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Abstract
<p>This document presents AEOLIX Living Labs Operational Impacts Assessment with a focus on socio-economic, business, and environmental aspects of the pilot implementation. The document also presents the degree of compliance with the needs of stakeholders and the business models implemented. The impacts of various indicators such Carbon Footprints (CO2 emission), fuel consumption, vehicle trips consolidation, empty truck runs, waiting times of trucks at terminals, loading/unloading times, terminal productivity, and load factor are calculated and compared to the impacts anticipated at the earlier stage of the project. Finally, the paper presents dynamic assessments by analyzing the impact of the monitored processes and data in relation to the operation of the involved stakeholders in real or near real time.</p>



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Abbreviations and Acronyms

Acronym	Definition
EC	European Commission
PO	Project officer
GA	Grant Agreement
WP	Work Package
LL	Living Lab
IS	Information Systems
IT	Information Technology
SCM	Supply Chain Management
KPI	Key Performance Indicator
PP	Project place
LCMM	Low Carbon Mobility Management
kg	kilogram
km	kilometer
LSP	Logistic Service Provider
SMEs	Small and Medium Enterprises
ICT	Information and Communication Technologies
SCM	Supply Chain Management
IT	Information Technology
LL	Living Lab
DoW	Description of Work (AEOLIX)
n/a	Not Applicable
nm	Not Measured

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Executive Summary

This document provides the AEOLIX impact assessment of living labs at the operational level. It is based on three main impacts namely business, environment, and socio-economic impacts. The three impacts are sub-divided further into sub-categories. The report collects data from twelve living labs involved in with AEOLIX.

One of the main goals of AEOLIX was to reduce the costs for various logistics activities as implemented in twelve living labs. The expected benefits in the business area are from reducing the consumption of different resources, reducing the time used for various activities, and from increasing the productivity in certain areas. The economic or business benefits came along two dimensions: (i) in terms of time and (ii) in terms of money. In terms of time, AEOLIX facilitated reducing the time spent on various activities at the companies. In terms of money, AEOLIX helped to save the costs of specific logistics activities within the living lab.

For the environmental aspect an overall value of 20% was set as target value for reduction in CO₂ emission using AEOLIX. Only one of all living labs reached this target value, but there was anyhow a reduction found in all living labs. AEOLIX and its functions have also helped in reducing noise pollution at some of the living labs. In some cases, there was quite a considerable reduction.

For the socio-economic aspects the job creation, SME empowerment, and the improved quality of life are addressed. This study has explored the impact of AEOLIX on job creation in terms of drivers' and operators' jobs. Since the AEOLIX implementation is still in its initial phases, respondents were unable to estimate how many jobs (drivers and/or operators) were created in the long run. SME Empowerment was measured as the increase in SMEs' market share and the increase in direct collaboration between SMEs and large organizations. The results were meager both with regard to the market share and the extent of collaboration. The improved quality of life is measured in the way AEOLIX puts more focus on work, the less stress at work and a positive attitude towards people using it. The results reflect that AEOLIX has greatly helped employees to put more focus on work and to reduce stress levels. Managers consider this as a positive side of the return on investment (ROI) as the business processes are improved. AEOLIX impact on various socio-economic aspects is in principle positive but as this process is very slow to emerge it takes time to observe any changes in social aspects.

Acceptance and trust on AEOLIX can be captured as a majority of the evaluation managers of the living labs found the AEOLIX functions (dashboard, connectivity engine and toolkit) useful to a great extent. The willingness to continue using AEOLIX functions and their usefulness are directly related to each other. This means that the more useful a function is, the more users are willing to continue using it.

The AEOLIX platform, through various services and functions, has a positive impact on society in general and on workers in particular. Although this impact cannot be evaluated financially for the first year of the AEOLIX implementation, numerous studies show that a more satisfying and less stressful job, together with a more welcoming and stimulating environment, have an important economic impact in the long-term period. Therefore, the fact that AEOLIX has a positive impact on society will also prove to be an economic benefit for the different companies.



Having a platform, such as AEOLIX, that connects to other systems, means that mitigation of risk and greater profitability of organizations can be achieved through connected and collaborative visibility. AEOLIX must leverage its position as a neutral certified information exchange, building trust and overcoming the major issues of culture that reside within supply chains. Capacity building for industry on digital connectivity could help. As more companies are added to the platform, even greater efficiencies will be delivered due to proliferation of synergies and strategic partnerships. In addition to the improvement of margins and asset utilization, the collaboration can reduce the company's overall km driven, leaving a smaller carbon footprint.

Finally, sharing information via AEOLIX turned out to be a part of an important debate during the implementation of the project. Although some companies see this as a big concern, yet this is not considered as a big hurdle in accepting and adopting AEOLIX.

1. Introduction

The main scope of the AEOLIX project is to increase overall visibility in the supply chain, across multiple modes and actors, making possible for each logistics actor to manage, (re)plan and synchronize facilities in the supply chain through a flexible cloud-based collaborative eco-system in a trusted business environment. Local ICT platforms will be connected through the eco-system to exchange information in a scalable, trusted and secure way – an example of trend of digitalization.

1.1 Purpose of the Document

The primary purpose of this document is to present the approach applied to evaluate the operational impacts of the deployed services implemented in the respective Living Labs and the AEOLIX platform where required. The KPIs identified in the evaluation framework from stakeholder consultations will be used and the Living Labs will monitor in real time information and data to be used for the dynamic assessment of the LLs. The analysis will focus on socio-economic, business and environmental impacts.

1.2 Structure of the Report

The report starts with a review of what constitutes “Operational Impact Assessment” and the three aspects that are covered:

- Socio-Economic Aspects which include Job Creation, Small and Medium Enterprises (SMEs) Empowerment, and Quality of Life;
- Business Aspects which include The Reduction of Operational Costs;
- Environmental Aspects which include CO2 Emissions (or Carbon Footprint) and Noise Pollution

Then the main content of the internal report WP6 Action Plan is presented with a number of steps and procedure. It starts with the identification of the functions being tested and continues with a selection of KPIs to be measured in each LL scenario. The data needed is identified and collected for the baseline and after a familiarizing and use of the new AEOLIX services, data with AEOLIX functions are collected followed by the analyses. The 12 Living Labs are described including the overall main objectives and the expected long-term effects.

The evaluation method and framework is presented and 4 categories of data collection is identified:

1. The KPIs Preliminary Investigation
2. The KPIs Interview guide
3. The survey Questionnaires
4. The Capture of Contextual information

Then three Result sections follow; Primarily the Operational Assessments of the LLs with AEOLIX. Then the Socio-Economic, Business and Environmental Impacts across the 12 LLs and finally an Integrated View on Impacts Assessment which will conclude the sections of Results.



1.3 Intended Audience

The intended audience of this document is the AEOLIX Living Lab beneficiaries, participants and stakeholders as well as the responsible Officers of the European Commission.

2. Operational Impacts Assessment – A Review of Literature

This is evident that digital technologies are rapidly transforming businesses around the globe. Like other industries this transformation holds valid for logistics and supply chain management. These technologies are connecting boundaries across various organizations to form interorganizational networks. These interorganizational information systems (IS) are improving information sharing and communication leading to seamless flow of information which results in seamless flow of goods (Williamson et al., 2004). This is also leading to cross functional information sharing and intraorganizational knowledge sharing as well (Eng, 2006; Akram, 2016). However, the quality of shared information is critical to reap the benefits out of this. Ultimately, the quality of shared information positively impacts operational supply chain performance, which, in turn, leads to improvements in overall firm performance (Hartono et al., 2010). This section will provide a review on operational impacts assessment along the following dimensions: socio-economic, business, and environmental impacts (as mentioned in AEOLIX grant agreement, Part B, Page 18).

2.1. Business Aspect

The value of IT systems has been an ongoing area of research for organizations and academics. Typically, an IT system is associated with either (i) enabler of innovative value creation; or (ii) source for saving costs thus producing value; or (iii) both (Masli et al., 2011; Schyren, 2013). This is proven that there is a positive direct or indirect effect of ICT on performance and SCM (Zhang et al., 2011). There is a growing trend towards increased investment in IT systems in general and emerging digital and online technologies in particular (Lancioni et al., 2003; Akram et al., 2019). This growing trend calls for evaluating the business value, a comprehensive IT system bring for companies and organizations.

2.1.1. Reduced Operational Costs

Reduction in operational costs is one of the most important aspects when it comes to business impacts of an IT solution. This has been an established fact in academic literature claiming that IT-based supply chain management systems have evident impact on business aspects. In such cases, SCM systems increase gross margin, inventory turnover, market share, return on sales, and reduce selling, general, and administrative expenses (see e.g. Dehning et al., 2007). However, findings include that correlations between IS investments and productivity vary widely among companies and that the mismeasurement of IS investment impact may be rooted in delayed effects (Schryen, 2013). Therefore, it is utmost necessary to have a perfect fit between information system and supply chain. This is because the higher the supply chain fit, the higher the Return on Assets (ROA) of the firm, and that firms with a negative misfit show a lower performance than firms with a positive misfit.

2.2. Environmental Aspect

Environmental concerns have never gained so much attention as they get today. With the increased number of industrial activities, globalization, outsourcing, third-party manufacturing etc. there has been a lot of pressure put on logistics transportation. This means that logistics operations are constantly or even exponentially increasing leading to serious impacts on environment. Furthermore,

United Nation (UN) has declared environmental sustainability as one of the its 17 goals. Keeping these things in view, it is utmost necessary to pay a close attention to environmental aspects.

2.2.1. CO₂ Emission / Carbon Footprints

Nowadays, it's a common practice to event-calculate the carbon footprints of the food eaten every day and its potential impacts on environment. A recent study shows that consumers are not only aware of carbon footprints, but also a decent number are buying products and services with low carbon footprints. This has been widely acknowledged that IT contributes to greener environment and sustainable business in logistics and supply chain management (Mingay, 2007; Benjaafar and Daskin, 2012). However, these are number of benefits and threat especially related to reducing carbon footprinting (Finkbeiner, 2009; Colegy et al., 2009; Chaabane et al., 2012). There are number of approaches to systematically measure carbon footprints (Sundarkrakani et al., 2010). Nowadays many supply chains are inherently designed to reduce carbon footprints (Elhedhli and Merrick, 2012).

2.2.2. Noise Pollution

Unlike carbon footprints, noise pollution is often passed unnoticed in considerations. However, where IT systems and tools contribute to minimizing carbon footprints of our activities, they are equally helpful to reduce noise pollution. In general, IT systems are believed to provide environmental benefits by contributing to reduction in noise pollution (Abbasi and Nilsson, 2012; Caris et al., 2014; Gubbi et al., 2013).

2.1. Socio-Economic Aspect

In general, 'socio-economic' is an umbrella term used to describe various aspects of inquiry including job creation, quality of life of workers, market share, financial incentives and availability of technology. For this study this studyhave focused on three of the sub-aspects related to socio-economic aspect of living labs implementation – job creation, SME empowerment and quality of life of workers. A brief description of each of these aspects are as follows:

2.1.1. Job creation

Job creation refers to 'number of new jobs' that are created in a company. There are number of reasons for new that may lead to new jobs. For example, one reason is that a new set of skills may be required as the introduction of new technology – AEOLIX in this case. Another reason includes the business of a company may increase because of the new opportunities offered by a technology. The literature regarding IT impact on job creation suggest the development of IT can have positive or negative impacts. These impacts of IT systems can lead to job loss, change of skills or new jobs with new skills (Ang & Pavri, 1994; Ho, 2007; Tremblay, 2003). However, IT is believed to accelerate the growth and facilitate job creation with new skills (Sabbagh et al., 2013).

2.1.2. SMEs Empowerment

SMEs play a vital and major role in the economy of a country. The trend has been especially emphasized in developed countries as well as the countries who are on their way of developing

economies. The literature suggests that ICTs adoption and assimilation in SMEs is critical to enhance their competitiveness. In addition, ICTs usage in SMEs will enhance accessibility into international markets (Ongori and Migiro, 2010). However, it is utmost necessary for SMEs to acquire unique ICT skills (Harland et al., 2007). Therefore, it can be stated that online information service infrastructure invokes relevant sophisticated IT services only if necessary and consequently delivers virtual technology capacity to SME users (Dai and Uden, 2008). In this regard, this can conclude that many IT tools and systems are being developed so that SMEs can increase their market share and partner-up with big players in the industry.

2.1.3. Quality of Life

It is very hard to find an employee without using some kind IT system or digital technology. IT systems are generally considered to improve the quality of our lives, whether in office or at home. However, different IT systems impact our quality of life in various ways and to a varying degree. The literature suggests that ICT, in general, has positive impact on quality of life (Korunka and Hoonakker, 2014). For an improved quality of life, organizations could pilot or implement flexible working hours and possible telecommuting initiatives (De Wet and Koekemoer, 2016). Finally, ICT lead to intensification and satisfaction of employees (Honnakker, 2014) so that they can put more focus on work and feel less stressful at work.

3. The Overall Approach

The main objective of WP6 is to evaluate the effectiveness and robustness of the AEOLIX solution. We will assess the usability, user friendliness and acceptance of the platform as well as the impact of the AEOLIX platform (connectivity engine, toolkit and dashboard) on freight and logistics operations. AEOLIX contains 12 Living Labs (LLs), for which the AEOLIX services and the LLs added value services and impacts will be assessed. The evaluation process is of vital importance for the success of the whole AEOLIX project because it gives to the project a more strategic structure, providing evidence for the results. The following action plan has been developed. Its purpose is to assist the Living Labs during the evaluation process.

3.1 The WP6 action plan

There are some critical steps for the evaluation process that must be followed by each Living Lab. The initial step 0 is for each LL to identify the specific functions/services that will be introduced. This will help highlight what they are going to evaluate. Then, a six-step approach will be implemented as graphically presented in Figure 1 below

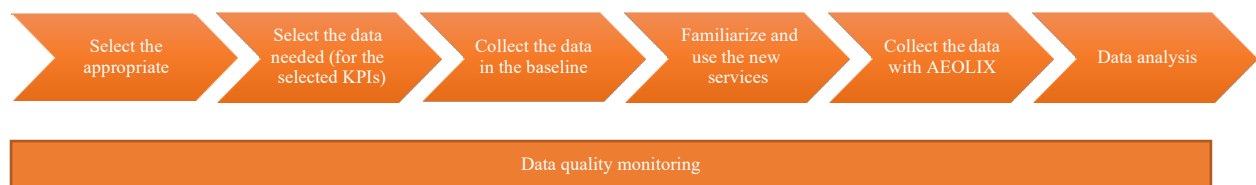


Figure 1: An overview of evaluation process

- **Step 1: Select the appropriate KPIs that will be measured in each LL scenario**

A list of selected KPIs has been identified in the framework of D6.1 based on the expected impact areas of each Living Lab. All Living Labs have already identified most of the KPIs that will be measured and the data that will be collected for the evaluation process.

A list of KPIs has been identified for each Living Lab.

In order to validate the overall performance of AEOLIX for all the use cases of all LLs, the process has been divided in two parts:

- The realistic choice among the selected KPIs (performed by the stakeholders)
- The comparison of the measurements between the “as is” (pre-test phase) and the “to be” (after test phase) situation.

The Table 1 below shows the list of KPIs measured by each LL (measured ones are shown with X, and not measured shown with 0), based on the questionnaire sent to all LLs in the context of D6.1. These KPIs have been changed during the evaluation process. Two of the KPIs – financial benefit, and acceptance and trust, were made compulsory to all living labs.

Table 1: KPIs measured by 12 LLs

KPIs	Living Labs (LLs)											
	1	2	3	4	5	6	7	8	9	10	11	12
KPI 1: Average fuel consumption	X	0	X	X	X	X	0	X		X	0	0
KPI 2: Average number of trips with consolidated cargo	0	0	0	0	X	0	0	0	0	X	X	0
KPI 3: % of Empty runs	0	0	X	0	X	0	0	0	0	0	0	0
KPI 4: Average waiting time	X	0	0	X	0	X	0	X	0	0	X	X
KPI 5: Average loading/unloading time	X	X	0	0	0	X	X	0	0	0	X	0
KPI 6: Terminal Productivity	X	X	0	X	0	X	X	X	0	0	0	0
KPI 7: % of Load factor	X	0	X	0	0	0	0	0	0	X	X	0
KPI 8: Average CO2 emissions	X	0	X	0	X	X	0	0	0	X	0	0
KPI 9: Administration work	0	X	X	X	X	X	X	X	X	0	0	X
KPI 10: Traffic avoidance/congestion reduction	0	0	0	0	0	X	0	0	0	0	0	0
KPI 11: Level of service	0	0	X	X	X	X	0	0	0	0	0	X
KPI 12: Modal shift	0	0	0	0	0	0	X	0	0	0	X	0
KPI 13: Custom Procedures	0	0	0	X	0	0	0	0	0	0	0	0
KPI 14: Visibility / data sharing	0	X	X	X	X	0	X	X	X	0	X	X
KPI 15: Interoperability	X	0	X	0	X	0	0	X	X	0	0	X
KPI 16: Financial benefits	X	X	X	X	X	X	X	X	X	X	X	X
KPI 17: Dynamic reconfiguration of shipments	0	0	0	0	0	0	0	0	0	0	X	0
KPI 18: Terminal handling efficiency	X	X	0	0	0	X	X	0	0	0	0	0
KPI 19: Reliability / Risks (Reliability of equipment)	0	0	0	0	0	0	0	0	0	0	0	0
KPI 20: Standardization	0	0	0	0	0	0	0	X	X	0	0	0
KPI 21: Acceptance and trust	X	X	X	X	X	X	X	X	X	X	X	X

Each Living Lab, depending on its specific activities, may measure some extra indicators, which will contribute to assess the impact of the proposed AEOLIX solution.

- **Step 2: Select the data needed (for the selected KPIs)**

After the selection of a set of KPIs by each LL, the data needed to measure those KPIs must be decided. A first selection of the data needed for the selected Key Performance Indicators (KPIs) is reported in the section "The choice of the data that need to be collected".

The following Table 2 shows the selected KPIs associated with the data needed in order to measure those specific KPIs.

Table 2: KPIs and type of data needed for measurements

KPIs	Data needed
KPI_1: Average fuel consumption	FC [l/km], FC^{-1} [km/l]
KPI_2: Average number of trips with consolidated cargo	no of trips with consolidated cargo / time unit, htrips cargo [%]
KPI_3: % of Empty runs	% of total veh-kms which are run empty, hdistance empty [%]
	% of total veh-hrs which are run empty, htime empty [%]
KPI_4: Average waiting time	Waiting time twait [h]
	Waiting time, ratio, ht, wait [%]
KPI_5: Average loading/unloading time	Activity time, tloading, tunloading [h]
	Activity time, ratio, hloading, hunloading [%]
KPI_6: Terminal Productivity	Gate throughput, Fgate [load units/h]
	Load unit time in terminal, tterminal
	<u>Load unit = trailer, truck, rail car etc.</u>
KPI_7: % of Load factor	Load factor, LF [%], Utilized capacity, Lused / Available capacity, Lavailable
KPI_8: Average CO2 emissions	CO2Eq [g/l], expressed as a function of fuel amount
KPI_9: Administration work	minutes, hours
KPI_10: Traffic avoidance/congestion reduction	Driving time (in hours or minutes)
	distance spent in congestion (in kilometers) relative to the total travel time (in hours or minutes)
	<i>distance (in kilometers)</i>
KPI_11: Level of service	Customer satisfaction for AEOLIX services
KPI_12: Modal shift	difference in % of cargo transported by rail or vessel (not by truck) over total cargo transported
KPI_13: Custom Procedures	time needed to execute customs processes in minutes
KPI_14: Visibility / data sharing	delivery arrived full (yes/no)
	Delivery arrived on time (yes/no, if no also delay in hours or minutes)
KPI_15: Interoperability	data latency or quality of exchange or time of interoperation)
KPI_16: Financial benefits	% of reduced costs
KPI_17: Dynamic reconfiguration of shipments	% of reconfigured shipments / total shipments

KPI_18: Terminal handling efficiency	total number of containers handled per day
KPI_19: Reliability / Risks (Reliability of equipment)	mean time between failure (e.g. Increase >10% / year)
KPI_20: Standardization	% of Automated reporting
KPI_21: Acceptance and trust (degree of approval of a technology by the user)	Usefulness
	Usability
	Perceived level of usability
	Perceived system consequences

- **Step 3: Collect the data in the baseline**

Data must be collected prior the implementation of the AEOLIX services, in order to assess the base case period and quantify the “before” situation. This base case period should last 3 months and every LL, depending on its readiness, should perform this activity.

- **Step 4: Familiarize and use of the new services**

Each LL will develop a set of functions/services based on the needs of its stakeholders and its community. These AEOLIX services will be implemented, in order to solve the identified issues and better address the needs of the stakeholders and local/regional communities. In the proposed step, we give the opportunity to the LLs to familiarize themselves and to use these new services in order to be ready for the data collection period that follows.

The verification of the AEOLIX solution will occur through the implementation of 12 LL trials or test cases. The Living Labs will examine and seek solutions to issues in the areas of process control, supply chain execution and network optimization. Each Living Lab has set different scenarios based on its operational challenges and for each situation different sources of data will be mobilized to populate the AEOLIX Dashboard or other added value services, developed by the LLs’ stakeholders.

The implementation of the services will have multiple impacts to a range of fields (socio-economic, business, environmental, etc.). Each LL will be assessed based on their specific services and data collected. The impacts identified will be compared to the impacts anticipated and target values in relation to the selected KPIs.

- **Step 5: Collect the data with AEOLIX**

A first specification on the collection of the data with AEOLIX can be found in the section “How to collect data”.

- **Step 6: Data analysis**

After the implementation of the AEOLIX LL services, the selected KPIs must be calculated, in order to perform the impact assessment. Data analysis will reveal the changes / improvements among the two phases (‘before’ and ‘after’), thus providing the necessary evidence regarding the success of each LL based on the expected objectives.

3.2 Living Labs descriptions

Living Lab 1 Description

Location: Port of Hamburg, Train track from Hamburg to Frankfurt Rhein Main Area, Germany. Hinterland to final customer greater Frankfurt Rhein Main Area.

LL1 ambitions: LL1 has defined his ambitions during the project within several deliverables summarized here as following:

- Multimodal, end to end, real time visibility for maritime container flows for the Logistics hubs Hamburg and Frankfurt, increased collaboration along the core network corridor.
- Re-align multi-modal based supply chain operations so as to enhance and to maintain the competitive performance of the Logistics hubs Hamburg and Frankfurt (incl. Hub2Hub supply chain),
- Increase hub competitiveness, efficiency and reduce emissions (e.g. CO2) and congestion for Hamburg / Frankfurt metropolitan area.

with regards to the following supply chain processes:

- container availability after unloading and customs clearance from a port container terminal in Hamburg provided by train terminal operator,
- the train status and the expected ETA of the train at the train terminal provided by train terminal operator, rail carrier and update by port community systems operator,
- the container availability after unloading the train and handling by the train operator, the inland terminal operator or the shunter,
- the container ETA to the final consignee, provided by the inland terminal operator or the shunter.

Concerning the environmental objectives and with respect to the AEOLIX toolkit capabilities LL1 has setup ambitions on decrease of fuel consumption and related CO2 emissions.

Target users and companies

Forwarder, LSP, Intermodal Terminal-Operators, IT Service provider, Shunter

Long term benefits and objectives have been broken down into two supply chain scenarios:

- **LL1 Scenario 1: Logistics Hub Hamburg, incl. Hub2Hub Hamburg – Frankfurt**
- **LL1 Scenario 2: Logistics Hub Frankfurt/Rhein-Main**

This Living Lab is tracks container movements from vessel in the port of Hamburg through the port terminal and by train to inland terminals in Rhein-Main. The rail operators are responsible for loading the trains with containers which are made available to them by the port terminal operators. Slots on rail operator's trains are booked by forwarders responsible for the customs clearance and onward transit of the cargo through to the inland terminals situated in Rhein – Main, the port hinterland.

The underlying main challenge is that currently the logistic partners along the supply chain are using individual planning systems, so that there is no full end to end visibility on the container shipment particularly at the loading location (port terminal) and at the unloading location (inland terminal). This causes a waste of time and shipping capability when achieving full rail wagon loads at the loading site and waste of carrier resources waiting to collect containers at the receiving end.

Summarized defined as :

- Increased efficiency through reduced standing time of assets (containers, trucks emissions),
- Optimization of train loading sequences leading to potential reduction of operational costs.

Living Lab 2 Description

LL2 TermiLab is focused on a trailer terminal for cross-docking where a forwarder, NTEX, operates a network of terminals with their own trailers. The transportation capacity is supplied by haulage companies (subcontractors). The main problem that we are addressing in this living lab is how to exploit real-time dynamic data and information related to the resources in the system e.g. trailers and terminals, not only the cargo.

The same also applies to handling equipment, trucks and load securing. In TermiLab, we will implement innovative data collection methods aimed at digitizing this often hard to define information so that it can be deployed by actors in the supply chain by making it part of the AEOLIX eco-system.

In TermiLab we need to fill in and update the operational information of the trailers and the terminals for the work teams to rearrange their schedules accordingly:

- From the Forwarders, the plans for incoming and outgoing freight at the terminals;
- From the moving Trailer, the GPS position so that the AEOLIX Toolkit can calculate ETA at consolidation terminal and inform forwarder and terminal of deviations of ETA at terminal;
- From the Terminal, trailer loading and unloaded information to forwarder so that the forwarder can send truck arrival information to trucking;
- From the Terminal, trailer arrival and unloaded cargo information to forwarder so that the forwarder can adjust plans accordingly.

Living Lab 3 Description

Thessaloniki wider area and industrial zone has links along the Pan-European Corridor X and the Orient —East Mediterranean Corridor Greece. It is an important hub for freight and logistics within the Balkans.

The Thessaloniki Living Lab aims to develop two services. The first service aims to streamline the inefficient use of road freight transport in Northern Greece and South-Eastern Europe by creating a cargo bundling platform for matching supply and demand between local exporters and truck owners. The second service focuses on the development of a Virtual Freight Centre (VFC) in Thessaloniki, providing warehouse sharing capabilities and increasing awareness for new logistics options, strategic opportunities, new sound business models and effective group action. This will lead to a testing of collaboration methods among stakeholders in Thessaloniki, creating new business models

and opportunities through new logistics services, opportunities and the development of a local ecosystem of LSPs.

Multimodal Virtual Freight Centre:

Logistics Service Providers providing warehousing services face difficulties in adapting to variable demand. Over and underutilized warehousing capacities exist, leading to inefficiencies for LSPs and their clients. These are due to lack of collaboration among LSPs, due to fragmented views in matching warehousing services' supply and demand and due to the lack of on-demand warehousing services. The AEOLIX LL collaborative environment exchanged relevant data and services to support the needs of LSPs providing or demanding warehousing capacity through demand-supply matching, quotation/booking management and warehousing analytics.

A web-based application was developed to support Logistics Service Providers (LSPs) providing warehousing services that are facing difficulties to adapt to the variable demand. For that reason, warehousing over- and under- capacity co-exist leading to inefficiencies for LSPs and their clients. In addition, the global tendency for on-demand services in many different areas, is now available on the warehousing sector. VFC offers "on-demand" warehousing services (pay-per-use) in the greater area of Thessaloniki, resulting in a very targeted scenario. Several use cases developed as shown below:

- Publishing of warehousing capacity supply data
- Viewing and search of warehousing capacity supply data
- Warehousing capacity supply-demand matching
- Booking of available warehousing capacity
- Data analytics

With the support of the TCCI, eight end users registered in the platform and exchanged and shared data to improve the visibility along the supply chain network and provide innovative services.

Cargo bundling marketplace and cargo monitoring:

Almost 30% of journeys in Greece are performed by empty trucks. In addition, non-empty trucks travel on average half-empty. These result to underutilized transport capacities and thus to lower efficiency for LSPs and users. There are barriers associated with fragmentation in matching demand and supply for freight transport services as well as with lack of horizontal collaboration. The AEOLIX LL collaborative environment utilized data exchange and innovative logistics services enabled through AEOLIX, to support LSPs and shippers through cargo demand/supply matching, quotation/booking management, cargo tracing and proof of delivery as well as corridor analytics to support policy makers. The companies participated in the pilot project were 5 (OFAE members) from the "supply" side and were 8 (SEVE members) from the "demand" side. Manufacturers - exporting companies reduced the transportation cost through shared loadings while road transport operators optimized their transport capacity by avoiding empty or half-empty trips.

The developed application aims to utilize data exchange and data sharing enabled through the AEOLIX architecture in order to support mainly the exporters and the road operators/truck owners. The overall target was to facilitate the use of road and multimodal freight transport between North Greece and South-east Europe by satisfying the requirements of the local production and distribution companies.

Various use cases were developed as shown below:

- Publishing capacity and demand data for freight transport carriers
- Viewing and search of road freight transport capacity data
- Road freight transport capacity supply-demand matching
- Booking of available road freight transport capacity
- Data analytics

The target was to provide a trusted environment for automated and trusted provision of demand - supply matching services to interested consignees, export companies, freight forwarders and road freight transport operators. The main services offered are: supply and demand matching, booking management, Track and Trace (T&T) and archiving data for statistical purposes.

Living Lab 4 Description

The Trieste port is a free port for goods since 1719, with five free zones in which goods can stay without customs formalities and fees, and manipulation of goods is permitted (e.g. packaging, repackaging, labelling, sampling, eliminating brands, etc.) as well as their industrial transformation, completely free from any customs bond. Trieste is the terminus of regular direct ocean transportation services provided by the world's main shipping lines to China, the Far East, Singapore and Malaysia, with stops in several other ports in the Mediterranean Basin (Albania, Slovenia, Croatia, Greece, Turkey, Egypt, Lebanon, Israel, etc.).

Due to the urban location of the Trieste Port without enough possibility of development, the Interporto di Trieste Inland Terminal area has been realized outside the urban context. It consists of 30.000 m² of warehousing and 130.000 m² of open space for parking/customs bond/storage yards and it is directly connected to the motorway A4 Torino-Trieste, the motorway A23 Tarvisio-Trieste and the motorway Trieste-Ljubljana.

LL4 addresses two main issues:

- (1) the improvement of the customs procedures and
- (2) the enhancement of the intermodal transport efficiency and quality.

- Customs procedures improvement.

AEOLIX will seek to improve customs procedure management by introducing secure and paperless data sharing procedures, enabling pre-clearing operations for both import and export RO-RO trades (roll-on/roll-off: a combination of road and sea transport, where loaded road vehicles are driven on to a ferry or ship and off at the port of destination) from and to Turkey. Moreover, AEOLIX will enable the monitoring of the movements of the trucks that have already performed the customs procedure at the Interporto di Trieste Inland Terminal but that have still to travel on the Italian territory in order to reach the port.

- Intermodal transport efficiency and quality enhancement.

To improve the end-to-end visibility of freight between the European hinterland and the port, AEOLIX will facilitate document transfer, booking, status and incident and emergency management, across multiple logistics operators; this will enhance operational quality and efficiency of the intermodal

operations, to such levels that even future growths will be easily manageable by the improved system.

In **LL 4 at the Port of Trieste**, import and export processes are being made more transparent so as to make planning more effective with vessel and truck ETA visibility along with reduced truck congestion and waiting times:

- From the vessel operator, ship arrival data, and freight data;
- From the Trieste DSS, pre-clearing communication;
- From the Trieste DSS, status on Custom operation at inland terminal;
- From the Trieste DSS, the ETA of trucks at the Port.

Living Lab 5 Description

Goods transports over inland waterways are part of a complex transport system mainly because of changing infrastructure conditions (e.g. water levels) and administrative barriers. Considering this, information availability and exchange between involved stakeholders represent a core aspect in the decision-making process.

The AEOLIX Danube Living Lab aims to develop and improve information flows by achieving a more accurate level of information exchange between different stakeholders involved in the transport process on the Danube waterway.

AEOLIX will implement a new layer of information exchange based on existing River Information Services, with a dedicated focus on delivering up-to-date and accurate information to authorised stakeholders in the transport chain.

In **LL 5** the vessel progress on the **River Danube** will be monitored, with vessel positions being made visible on maps, and vessel ETA and availability for new business being made visible to multiple stakeholders:

- From the vessel owner/operator, introducing vessel information in AEOLIX;
- From the RIS system, ETA updates in AEOLIX based on ETA updates in RIS systems;
- From the vessel owner/operator, manually updating ETA in AEOLIX;
- From the RIS system, position updates in AEOLIX based on the AIS data; accessing map content in AEOLIX based on the viewing rights on vessels;
- From the vessel owner/operator, vessel availability notifications.
- From the carrier/ logistic operator/ forwarder terminal slot arrival notifications

Living Lab 6 Description

The objectives of the Bordeaux Living Lab are the improvement of data flow from shippers and operators (especially SME's) to the Bordeaux port and authorities with respect to required reporting customs clearance and dangerous goods control. The main goal is to win time by proposing solutions optimizing the goods management during the key phases of the supply chain. This integrates services like estimated time of arrival, data interoperability and secured transfer of data including dangerous goods, appointment services by smartphone and container or bulk delivery and pick up management.

By integrating port and road transport in an interoperable and paperless way the global time necessary for transport of goods will be reduced. Existing tools developed in research projects Noscifel and GeotransMD will be finalized and interconnected to the AEOLIX platform.

Multimodality is also key to the success of our living lab by proposing rail transport between 2 of the Bordeaux terminals which will permit the reduction of the number of trucks on the roads.

Data security is also crucial so that all actors of the supply chain participate in a confident way and this subject will be tackled by the adaptation and use of the GeotransMD TP1 highly secure platform supported by the French Ministry of Transport.

Finally, an ambitious and complete mobile app will be developed and proposed in priority to truck drivers but also to the other actors of the supply chain which are used to work outdoors.

In Bordeaux, truck location and relevant dangerous goods freight information are being integrated and made visible to critical stakeholders to ensure port safety, and truck scheduling at terminals is being more efficient:

- Current position, destination, of trucks, truck type, start time;
- Information about the truck (Plate Number, VIN) and dangerous goods information (Container ID, UN Number) to AEOLIX CE, sent to Cargo Community System and to port access control;
- The position of the truck with dangerous goods;
- From the fuel-terminal operator, the different time slots for each loading area and fuel type associated.

Living Lab 7 Description

FMCG Lab aims at improving the flows of incoming goods to a large distribution center (COOP DC) for fast-moving consumer goods (FMCG) in Sweden. The DC receives several trailers per day via road and rail from Malmö intermodal terminal. The problem today is lack of high-quality information regarding incoming shipments which, in turn, leads to inefficiencies at the DC. FMCG Lab will implement enhanced information sharing between rail operators and terminal operators so that COOP (and others in the same system) will get better data and thereby be able to make better, more informed plans and decisions.

For the **COOP retail organization in LL 7**, visibility to shipment availability and rail ETA are being sought to reduce terminal operation times and enable continuous monitoring of goods and re-planning of DC work:

- From the forwarder, trailer cargo information;
- From the Terminal in Malmö (Mertz), train loading (wagons on train) to inform arrival terminal (Coop Bro);
- From the Railway operator (Rail IT/TX Logisitk), train schedule and updates ETA to terminal planners (CoopBro);
- From the Terminal planners (COOP Bro), available time slots for loading, to terminal operator;

Living Lab 8 Description

Unilever is a global manufacturer of fast moving consumer goods (FMCG). This Living Lab is about primary outbound deliveries from Unilever production plants to the national distribution centers. The Unilever Ultra Logistics Control Center is responsible for planning and execution of the international inbound shipments across Europe, in close conjunction with the managers at the production sites



across Europe. In this Living Lab, Unilever has selected a site in Poznan, Poland to develop the Use Cases to be implemented.

At each production site, there are a variety of different Carriers executing the freight transportation, each of them having their own kind of IT-system and at the same time this Carrier must respond to each Customer's TMS.

The challenge is that currently there is no full end to end visibility of the freight shipment availability, particularly at the loading location (production plant), with the Carriers, or at the unloading location on final delivery. This causes a suboptimal use of shipping capability on the loading site and waste of resources at the receiving end.

To meet this challenge, it is imperative that Unilever and the executing carrier have agreed time windows and capacity information available to support their operational planning and day to day activities. To have a common collaborative environment in place should reduce current inefficiencies and serve as best practice for the other shippers and Carriers in FMCG or similar industrial sectors

At production sites managed by **Unilever** under LL 8, product shipment load size and availability is being supported by a shared AEOLIX Dashboard view so that LSP's can adjust their schedules and reduce waiting time:

- From Unilever ERP, shipment availability data to indicate required capacity for freight transport carriers;
- From the Warehouse operator, Publishing of Distribution Centre and warehousing capacity supply data;
- From the truck operator/LSP, Track and trace information on position and ETA.

Unilever has focused on UC1.1, closing the data gap around production availability as apriority, to also serve as a basis for managing access to plant sites of the trucks.

Use Case UC1.1 Unilever plant staff updates available pallet quantity and availability information. This information is shared via the AEOLIX Dashboard with the transport company. This is intended to reduce truck waiting time - and resultant costs and engine idling time – at the factory gates.

The Use Case has been expanded to include managing access to the factory location. The factory gate can record actual truck arrival time and departure time via the AEOLIX Dashboard, and thus create a historical record of truck time inside the factory gate, as a basis for better management of both waiting time and loading slot allocation.

The two other Use Cases regarding End-to-End Traceability and Slot Booking will be revisited at a later stage.

Living Lab 9 Description

The aim of the business case is to enhance network efficiency and effectiveness and the use of cross-chain capacities to optimize employment of assets and services and realize reduction in overall logistic costs and externalities.

In delivering transportation services Jan de Rijk Logistics is not able to collect complete status information along the entire intermodal rail-truck service. The end-to-end visibility is still lacking or by unstructured information.

Increased risk caused by irregularities in operations during rail operations and ferry crossings cause operational complications in the management and execution processes. On the contrary service providers of trains (terminals), ferries and the channel tunnel tighten their capacity schedules and requirements. This causes adjustments in the planning and scheduling and during the execution of the process.

AEOLIX will facilitate structured messaging for end-end visibility and complex event-management with notifications sent by intelligent agents, real time, with flexible planning and booking interfaces.

AEOLIX will facilitate optimization with scenario-based, cross-chain interconnected logistics, integrated data management, controlled by a neutral central logistics service provider (LSP). Shippers will collaborate via LSP on an operational level, bundling multi-modal freight and efficiently combining transport capacity and demand, enhancements can be expected in capacity utilization and a strengthen cooperation between LSP and shippers identifying and sharing mutual benefits;

Under **LL 9 at the operations of Jan de Rijk**, continuous monitoring of shipment pick-up times, train loading times and sequence, as well as subsequent rail and truck ETA's is being pursued to reduce truck waiting times, which can be significant:

- From the trucking unit, the ETA of the truck with a container at the departure railterminal;
- From the railway terminal operator, load sequence of the container;
- From the railway operator, the train ETA at the arrivalterminal;
- From railway terminal at arrival, the availability of container after unloading and handling;
- From the trucking unit at arrival terminal, the ETA of final delivery at consignee.

Living Lab 10 Description



Figure 2: Areas covered by LL10

LL10 is located in Spain and covers the areas as shown in Figure 2. Logistics improvement is at an advanced stage at regional level (33% of production) in CEAGA since the companies grew up according to PSA Group Vigo plant needs. Potential logistics improvements are in the 66% of the remaining production to national and international customers, which has been individually managed by each company with their respective customers (outbound) and providers (inbound). The Figure 2 above shows the main area of this living lab.

Through AEOLIX, the cooperation and information exchange between automotive suppliers will allow:

- Searching of synergies between companies which allow optimizing of freight transport in existing routes.
- Balancing in-bound and out-bound, taking advantage of empty returning trucks and returnable packaging recovery.
- Creating new routes according to potential new needs generated by returns (opportunities identifying)

The main objective is to enable network optimization through load factor and capacity optimization through horizontal collaboration.

- Supporting the automotive components manufacturers in the Galician Automotive Cluster (CEAGA) to enable their collaborative management of the transportation of automotive components, searching of synergies between companies which allow optimizing of freight transport in existing routes
- Information interchange in order to detect opportunities to fill trips which otherwise should not be fully loaded, balancing in-bound and out-bound taking advantage of empty returning,
- Reduce stock keeping and transportation cost, increase service levels and reduce environmental impact

LTL loads are being analyzed and co-loading is being investigated to seek efficient planning and effective reduction of costs and truck movement:

- From the users' in-house analytic system, route information with matching opportunities;
- From users, proposal for matching loads;
- From trucking firms, transportation bid prices.

Target users and companies

The main users of this living lab are mainly suppliers of the PSA factory and logistic operators

Long term benefits and objectives belong to the following scenario:

- Creating visibility through AEOLIX, on in-bound flow of raw materials and sub-components to the component manufacturers plant while facilitating the return of re-usable packaging to TIER 2 & TIER 3 Suppliers.
- **Use Case:** To exchange planning information and data at a high level in order to share logistics routes to improve the competitiveness in the Galician Automotive Sector. Then provide operational information to support the execution of the shipment.

- **Objective:** to facilitate the balancing of in-bound and out-bound flows by taking advantage of empty returning trucks and returnable packaging recovery.
- Issue: Currently the three manufacturers selected for this scenario manage their own inbound supply chain logistics partners independently, without horizontal collaboration. Today these businesses will order products and schedule collections and deliveries entirely separately through disparate IT architectures and ad-hoc processes managed by emails and phone-calls.
- The critical steps of the freight execution are planning steps such as coordinating collections at common suppliers, combining deliveries from several suppliers, and collecting and returning re-usable packaging to the sub-component manufacturers.
- Actors involved:
 - TIER 1
 - TIER 2 & TIER 3
 - Service Provider Cross Dock
 - Carrier
- Description – A TIER 1 manufacturer wishes to schedule a collection of a ILTL (Less than truckload) of product from a TIER 2 & TIER 3 supplier. The TIER 1 transport scheduler wishes to check to see if there is a consolidation opportunity with another TIER 1 Manufacturer (Supply consolidation – truck collects both TIER 1 shipments on same visit) or a consolidation opportunity with another TIER 2 supplier (Delivery consolidation – truck collects from two TIER 2 & TIER 3 suppliers and delivers to TIER 1 Manufacturer). Where cost and time constraints may allow, these activities can take place via a Service Provider ‘cross dock hub’ or milk run where deliveries and collections can be transshipped from truck to truck, ensuring that trucks arrive at the hub full from the TIER 2 suppliers, and leave full to deliver to TIER 1 manufacturers. Returnable packaging can be collected at delivery and returned to the TIER 2 & TIER 3 Supplier on a subsequent collection by the carrier.

The expected results include:

- Improved load factor as TIER 1 contract for full trucks and larger capacity trucks. More larger trucks are cheaper and less environmentally damaging than many smaller trucks.
- Improved vehicle utilization as empty legs are reduced through matching shipments of returns and returnable packaging to collections of TIER 2 & TIER 3 Supplier products.
- TIER 1 Manufacturers may collaborate individually, or through Service Provider Cross Docks.

Living Lab 11 Description

Mondelez Control Tower receives its transport orders manually from the Mondelez production plants. The inefficiency of the manual transport order handling results in higher transport management cost at the shipper side. AEOLIX will try to find solutions to improve data accuracy and reduce the cost of the direct transport management.

Mondelez does not provide visibility on waiting time at the loading and the unloading locations to the carriers, which can result in waiting time of assets. AEOLIX would provide visibility on waiting time to carriers.

Mondelez as shipper does not receive visibility on the truck location from the carriers and cannot predict the estimated time of arrival. The late transport can cause loss of sales at the shipper side. AEOLIX will visualize the truck location for the shipper.

Under **LL 11 for Mondelez**, product shipment load size and availability is being supported with a shared AEOLIX Dashboard view so that LSP's and warehouse operators can adjust their schedules, improve load factors and reduce waiting times:

- From MDLZ ERP, updates of Delivery Notes (DN) with available pallet quantity information and Load Control Centre (LCC) User Updates Carrier on estimated time of loading start;
- From the Warehouse operator, information on the number of available docks is updated on the AEOLIX platform and Carrier plans rest times and arrival to location accordingly;
- From a MDLZ contracted system, GPS information and updates for the receiving site with ETA of trucks with urgent shipments, as calculated by the PTV Toolkit application.

The Use Cases under Scenario 3 were not implemented due to a change in corporate system configuration that discontinued the proposed data feed. In principle, they remain valid as to be pursued when the integration of a new TMS system is completed at which time they can be re-visited.

New Use Case Developed – Scenario 4: Order Optimization

Use Case UC4.1 MNDLZ has developed a new Use Case under Scenario 4 that makes possible combination of loads from MNDLZ with loads from other shippers. A specific (Confidential) third party LSP will be requested to review each day's Orders to combine these into a consolidated load to create a new Shipment.

The Carrier will be enabled to propose a new Shipment with a rate for the Shipment execution within the parameters of the individual Orders, as to date available and required Delivery Date.

This will result in increased load factors and hence lower costs and lower CO2 emission per volume of shipment tendered.

Living Lab 12 Description

Supply chain digitalization through digital CMR note. The European corridors affected are:

1. Facilitation of trade to the East - involved partners: OFAE (GR), UNTRR (RO)
2. Integrating the Balkans – involved partners: UNTRR (RO), CCIS (RS)
3. From Med to Central Europe – involved partners: OFAE (GR), CCIS (RS), BGL (DE)
4. The road to Scandinavia – involved partners: BGL (DE), CESMAD (CZ)

LL12 will showcase the potential of digitalization in transport and its contribution in increasing the visibility across the supply chain of national and cross-border operations across Europe using digital freight transport documents.

LL12 will focus on several corridors in Europe which, from recent AEOLIX investigations (AEOLIX D2.3.1), have resulted as network-wise critical for freight transport operations in Europe in order to address the greater scope of digital freight transport documents.

Long term benefits are:

1. Significant reduction of administrative works due to reduced data entry, no paper handling, no fax/letter/scan exchanges, no archiving, faster invoicing, real-time access to information and to proof of pick-up and delivery. Expected reduction: 3 to 4 times less effort to be evaluated in temporal and monetary KPIs.
2. Reduced inspection time due to faster access to information, faster back-end research and cross-check on behalf of road authorities. Expected reduction: up to 7% less time on the overall transport (from pick-up to delivery and finally to invoicing) – be evaluated in digital vs. paper-based operations during LL operations.
3. Environmental friendlier operations due to less sheets of paper issued and carried. Expected reduction: only regarding vehicles 135 tons of wood are used for the paper documents carried during a transport assignment. Results to be extrapolated in other business sectors based on LL operations.

3.3. Data Collection Guidelines

This section present the guidelines on how to collect data for different KPIs in various living labs (LLs). These guidelines also show how to calculate value for each of the KPIs, sources from where or whom the value should be collected and units of calculations.

Fuel consumption and carbon footprint: can be measured with a data logger integrated to the truck. Position GPS or telematics on fleet management. Data should be received from the haulers which work as Living Lab partners. Carbon footprint can be calculated from the fuel consumption if the fuel type is known. (cp. The GLEC Framework).

- FC [l/km];
- FC^{-1} [km/l];
- CO_{2Eq} [g/l], expressed as a function of fuel amount.

Consolidated trips: KPI could record the number of trips with consolidated cargo per time unit. Data needed will be obtained through the Living Lab control tower and the cooperating hauliers.

- no of trips with consolidated cargo / time unit, $\eta_{trips\ cargo}$ [%].

Empty runs: can be measured by vessel management application. PI record the booking of cargo on empty vessels through AEOLIX platform. Data needed should be obtained through the Living Lab control tower and the cooperating hauliers.

- % of total veh-kms which are run empty, $\eta_{distance\ empty}$ [%];
- % of total veh-hrs which are run empty, $\square_{time\ empty}$ [%].

Waiting time for trucks in the terminal: this PI could be measured by logging the entry time and the exit time for the truck in the terminal. GPS position or surveys among truck drivers and transport operators could be used to assess the average waiting time. Management of access to terminal gates will be more transparent using the AEOLIX platform and, therefore, less allocation time to the

docks will be needed. Data should be obtained through the Living Lab control tower, the distribution centre and the cooperating haulers.

- Waiting time t_{wait} [h];
- Waiting time, ratio, $\eta_{t, \text{wait}}$ [%].
-

Average loading/unloading time: the trailers are allocated to docks close to goods location in the distribution centre thus reducing the total loading/unloading time. PI can measure the average truck turnaround time at the distribution centre. Position GPS, data loggers to the docks can be used to measure the respective time.

- Activity time, $t_{\text{loading}}, t_{\text{unloading}}$ [h];
- Activity time, ratio, $\eta_{\text{loading}}, \eta_{\text{unloading}}$ [%].

Terminal productivity: the trailer will be assigned to docks more swiftly thus increasing the efficiency of the loading procedure and the overall terminal productivity. PI can be measured from the number of trucks processed by the terminal per time unit. Data needed should be obtained through the Living Lab control tower and the distribution center.

- Gate throughput, Φ_{gate} [load units/h];
- Load unit time in terminal, t_{terminal} ;
- Load unit = trailer, truck, rail car etc.

Load factor: the load factor is the ratio of the average load to total vehicle freight capacity (vans, lorries, train wagons, ships), expressed in terms of %. The increase could be shown in a survey or questionnaire among logistics service providers, transport operators and freight forwarders. Data could also be obtained through the Living Lab control tower and the haulers.

- Load factor, LF [%], Utilised capacity, $L_{\text{used}} / \text{Available}$

capacity, $L_{\text{available}}$.

Administrative work is measured in hours or minutes.

The number of containers, either a cargo transported (by truck, ship or rail) relates to modal shift and/or reconfiguration.

The number of failures per day (or week) can be measured to capture the reliability of the system and the standardization is addressed by measuring the commanded vs. the automatic collection of data.

Level of the services and Visibility or data shared can be addressed using a questionnaire.

Acceptance and trust: Acceptability indicates the degree of approval of a technology by the users. It depends on whether the technology can satisfy the needs and expectations of its users and potential stakeholders. Within the framework of introducing new technologies, acceptability relates to social and individual aspects as well. Regarding the dimension of “Acceptance and Trust”, the following subjective KPIs should be focused on during FOTs:

Ex-ante usefulness (level of usefulness perceived by the user prior to usage): before using a system, what are the dimensions of usefulness that occur to the future user immediately? What are the benefits he/she expects from using the system?

Ex-post usefulness (level of usefulness perceived by the user after practice with the system): after first use of a system, what are the user's impressions regarding the system's benefits? Ex-post usefulness must be analyzed in relation to the statements of the indicator on "ex-ante usefulness."

The reactions to both indicators will give useful information for system acceptance. The measurement of these two indicators can be operationalized via self-designed questionnaires, based on established methodological approaches (see Nielsen, 1993; Grudin, 1992). A qualitative approach like a focus group with a formalized protocol and individual in-depth interviews is also appropriate. The observed rate of the use of the system or of specific system parts represents an additional indicator for system acceptance and perceived usefulness.

Perceived system consequences (perception of positive or negative consequences of the system's use) is another key indicator for system performance: the user expresses his/her impressions and attitudes regarding the potential consequences when using the system, which can be positive as well as negative. These impressions can best be collected via an interview and can be exploited in focus groups. They have the advantage of group dynamics that can provide additional information on the subjective norm. Construction of standardized questionnaires is possible as well (for a background on methodology on this indicator, see Featherman and Pavlou, 2003).

Motivation (level of motivation/impetus to use the system) should relate to the indicator "Behavioral intention" (level of intention to use the system). This indicator can best be investigated via self-designed questionnaires based on established methodological findings (see Armstrong, 1999; Ajzen and Fishbein, 1980). The response to perceived social control/response to perceived societal expectations indicates the impact of perceived social control of the user's behavior. This FESTA Handbook Performance Indicator is a more sociological one, which should give an indication whether the user feels a social benefit (for example, social recognition) when using the system or, on the contrary, that he/she hesitates to use the system due to fear of social disapproval when using the system (see Castells, 2001).

Usability/level of perceived usability concerns the aspects of the user's general capacity to interact with the system (including installation and maintenance, see Grudin, 1992; Shakel & Richardson, 1991). For these indicators, a combination of in-depth interviews, focus groups and self-designed questionnaires based on established methodology is recommended. The general ease of use of a device will have a major influence on acceptance. Here, ease of use refers not just to the usability while using it but to the user experience in all aspects of usage—pre-use, in-use and post-use.

All the additional KPIs and the way to be measured can be found to the D6.1 and the questionnaires sent to all LLs.

3.3. Data Collection Support Meetings

In addition to guidelines document and distributing surveys, over 100 meetings were held with different living lab leaders and other stakeholders within those living labs. These meetings were conducted with living labs evaluation managers, companies managers and other participants involved in the data collection process. The meetings were multi-purposes depending upon (i) the requirements of participants; (ii) status of project development and implementation; (iii) the phase in

which evaluation process is; and (iv) requirements mentioned in AEOLIX agreement. Main purposes of the meetings include the followings:

- An overall guideline for data collection
- Helping respondents in understanding various surveys and questionnaires
- Describing what kind of data is needed to be collected
- How the data should be collected and measured
- Confirming and validating responses
- Explanations for particular responses
- Feedback on responses interpretations

3.4. Data analysis and reporting

Information is only useful if it is analyzed and put to good use. A key purpose of monitoring is to support internal decision making and planning in order to ensure periodically analysis, assess, and use the collected information. The data has been collected in the forms of quantitative and qualitative information. Quantitative information included calculating simple totals, averages, and percentages, and statistical tests (if appropriate). On the other hand, qualitative information include interpretations of findings in relation to questions sent to each living lab. During the process, this study watched out for unintended results & data that does not fit your expectations. The data analysis and reporting included the following processes:

Collection of the list of KPIs and measurement methods for each KPI

- Collection of responses and converting data in structured forms
- Analysis of data resulting in graphs and descriptions
- Interpretation of graphs and other structured data based on collected materials
- Sending quantitative and qualitative information back to respondents for internal validity checking
- Reporting the results in this report
- Sending the results to relevant living labs evaluation managers for feedback and responses on results and interpretations made
- Making review and adjustments to the report based on comments and discussions with living labs evaluation managers
- Engaging experts within the AEOLIX project through the evaluation process to ensure external validity and thus providing an objective view
- Making periodic evaluations and checking with living labs evaluation managers

4. Evaluation Method and Framework

The evaluation of AEOLIX living labs operational impacts assessment focused on the following aspects:

Socio-economic impacts

The socio-economic aspects for AEOLIX living labs (LLs) operational impacts assessment includes job creation, SMEs empowerment, and quality of life of workers.

Business impacts

Business aspect for AEOLIX living labs (LLs) operational impacts assessment is mainly focused on reduced operational costs for various logistics activities.

Environmental impacts

Environmental aspects for AEOLIX living labs (LLs) operational impacts assessment includes two major sub-aspects named as reduced carbon footprints and noise level at work.

In order to capture the impacts assessment at operational level, this study used a mixed method approach consisting of quantitative as well as qualitative methods. The quantitative data collection includes conducting surveys and analyzing by calculating simple totals, averages, and percentages, and statistical tests. On the other hand, qualitative data was collected using interview guides and interpreting findings in relation to questions. During the analysis, this study watched out for unintended results and data that does not fit to expectations. So far, the data has been collected from various actors within all living labs. These actors include living labs evaluation managers, company representatives or managers, operators and drivers.

Furthermore, it was realized that the operational impact assessment involve various types of aspects as follows:

- Some of the aspects can be measured quantitatively, given that a numerical value is available. For the AEOLIX living labs operational impacts assessment, reduced operational costs (business) and carbon footprints (environmental) could be measure quantitatively. This means a numerical value is possible to calculated for CO2 emission and operational costs.
- Some aspects could only be measured qualitatively. These aspects include SMEs empowerment, job creation and quality of life (socio-economic) and noise pollution (environment). For these aspects, qualitative surveys (for companies in living labs, operators and drivers) and qualitative KPIs (e.g. level of service, Acceptance and trust) were used to assess the impacts on the operational levels.

4.1. Data Collection I – KPIs Preliminary Investigation

This study started with a preliminary investigation by asking the following information to each of the living labs:

- A list of KPIs for all living labs was collected at the beginning of the AEOLIX evaluation phase. During Fall 2018, living labs evaluation managers were asked to update the list based on the emerging situation at that time. The emerging situation included a pragmatic assessment of data that can be collected throughout AEOLIX. A special consideration was paid to each living lab operational environment as well as AEOLIX implementation in each stage. This updated list of KPI reflects deviations from the original list that was compiled at the beginning of AEOLIX evaluation phase.
- After obtaining the updated list of KPIs, this study also collected information on the method of calculation for each KPI. It used sources from where the data will be collected. The

calculation methods for each KPIs was developed with living labs evaluation managers at earlier stages of AEOLIX. During living labs operational impacts assessment in this study, updates regarding calculation method for each KPI were recorded. These updates were recorded in the data set for the analysis at the later stages. In addition to KPIs calculation methods, this study also collected data about various 'items' for all KPIs. For example, for the KPI 'increase in the percentage of consolidated cargo' a description or definition on what is meant by consolidated cargo for different living labs, was sought after. This was necessary to collect such information since the definition of 'consolidated cargo' may vary from one living lab to another. For instance, one living lab may consider 90% of a filled cargo unit as consolidated cargo while another living lab want to consider 100% of a filled cargo unit as consolidated. This data collection activity allows us to capture contextual information associated with each KPI for a particular living lab.

- The next step in data collection was to gather information about various services that have benefited from the AEOLIX solution. This was further compensated by which KPIs contribute to the provision of each service. This can be illustrated by an example as follows: AEOLIX solution has facilitated secure and paperless data sharing through a mobile application to Living Lab 4 (LL4). This service has facilitated document transfer, booking, status across multiple logistics operators transporting freight from continental Europe to Turkey and return passing through the Trieste port. In this regard, 'KPI on level of service' (KPI 11 in the list) and KPI on data sharing/visibility (KPI 14 in the list) will be used for the provision of seamless data sharing services. This information has helped to establish correlation between the KPIs and services benefiting from the AEOLIX solution at the operational level. Major participants for this information were living labs evaluation managers and associated company managers, if the evaluation managers were lacking information on this.
- After establishing the list of KPIs, their calculation methods and services they contribute to, this study collected information about which KPIs impacts on various operational impacts. These operational impacts covers socio-economic, business, and environmental as well as their respective sub-aspects. In addition, perceived impact level (high, medium or low) as well impact type (direct or indirect) were also recorded. This information provides a direct feed on the contribution made by each KPI to various aspects within a different living labs.
- Last but not the least, this study collected updated data on AEOLIX companies and users. The necessity of this data collection activity emerged from the fact that a number of living labs have gone through change in their structures. This means that different companies left or joined during the AEOLIX development. Therefore, a clear picture is necessary to make operational impact assessment.

1.1. Data Collection 2 – KPIs Interview Guide

After the preliminary investigation on KPIs, services and their relations with socio-economic, business and environmental aspects of different living lab, this study collected data using the KPIs detailed interview guide. This guide was intended for living labs evaluation managers. We have prepared 12 customized interview guides for each living lab. The customization of these interview guides was based on data collected in data collection 1. This means that one interview guide was designed for each living lab evaluation manager based on the list of KPIs provided during data collection 1. However, questions for each KPIs interview guide have the following characteristics:

- A numerical value is recorded for each of the KPI selected. This value reflects BEFORE and AFTER situation. For example, we have collected data about ‘average fuel consumption’ before and after AEOLIX.
- The interview guide contains questions about how each KPIs is impact, related or contribute to different operational aspects, that is, socio-economic, business, and environment.
- Real-time examples for the selected KPIs were recorded in order to see any commonalities or patterns across living labs.

1.2. Data Collection 3 – Survey Questionnaires

Survey questionnaires were another important source of data collection. As mentioned earlier that a number of the aspects (SMEs empowerment, job creation, quality of life and noise pollution) could not be measured quantitatively, therefore different surveys were designed to collect information about these qualitative aspects. The surveys were designed in a way so that a quantification of qualitative data was possible. We have designed three different surveys for various companies and users of AEOLIX. These three surveys include:

Company representative (/Manager) Survey – This survey was intended for an operational level representative such as a manager at a company within living lab. The survey captured both qualitative as well as quantitative data. An example of qualitative data is the extent or degree to which a company or an organization manager found AEOLIX useful in reducing noise level at his/her workplace. On the other hand, an example of quantitative data is ‘Time spent or saved’ in terms of number of hours for various logistic activities, processes or operations.

Operators Survey – This survey was intended for operators at a port, terminal or a hub. The purpose of this survey was to collect data about operator’s quality of life, noise pollution and usefulness of AEOLIX in his/her daily work. This information can be useful to describe the quality of life, noise pollution, and acceptance of AEOLIX platform.

Diver Survey – It was found in earlier AEOLIX studies (e.g. D 5.3) that many companies in different living labs were interested in the use of AEOLIX for road transportation i.e. trucks. In this regard, some of the living labs (such as living lab 6 at Port of Bordeaux) has installed an IT system linked to AEOLIX to capture the feelings and feedback of drivers. The living lab, already, has conducted an extensive survey with drivers of Samat (a truck company in Bordeaux associated with the Port of Bordeaux) to get their input and feedback. Similarly, living lab 2 (Termilab Gothenburg) has involved third party logistics providers to calculate various aspects associated with the use of AEOLIX.

1.3. Data Collection 4 – Capturing Contextual Information

In addition to KPIs interview guide and survey questionnaires, this study has tried to capture contextual information of each living lab as much as possible. However, capturing contextual information is a trivial task since it requires time, additional resources, accessibility to living labs and their users. This study has used various methods to capture contextual information. These methods included the following:

- Visit to living labs – the purpose of visiting a living lab is to gather information from employee on site which is difficult to collect otherwise. For example, a process map of activities that goes around within a company or an organization. Another example includes capturing

contextual information about items in KPIs (for instance, different companies have different interpretations and definition of various items in KPIs). So far, one visit has been made to living lab 6 at Port of Bordeaux, other companies and users within the living lab.

- Documents – various documents (like the ones mentioned in data collection 1) have been created to capture contextual information about companies and users, items in KPIs, services benefited from AEOLIX, and impacts, relations or contributions of various KPIs to various aspects associated with operational impacts assessment.

The following Table 3 provides summary of various data collection activities in order to provide AEOLIX living labs operational impacts assessment.

Table 3: Summary of data collection activities and sources

Data Collection	Activities	Participants	Purpose
Data collection 1	Preliminary investigation	LLs evaluations manager	Updated list of KPIs, services benefited from AEOLIX, KPIs and aspects inter-relationship
Data collection 2	Interview guides	LLs evaluations manager	KPIs evaluation, reasons for increase or decrease in value
Data collection 3	Survey questions	Company managers or representatives	Noise pollution, SMEs empowerment, job creation, quality of life, time and money savings, acceptance of AEOLIX
		Operators	Noise pollution, quality of life, acceptance of AEOLIX
		Drivers	Noise pollution, quality of life, acceptance of AEOLIX
Data collection 4	Company visits	LLs evaluation managers, company managers or representative,	Contextual information

5. Results I – Operational Impacts Assessments of LLs with AEOLIX

For all the assessed Living Labs (LLs), the evaluation of AEOLIX impacts has been made on the basis of available self-reported questionnaire answers and measured KPIs at each participating LL. Most descriptions are based on surveys of KPIs, and when appropriate also the Manager, Operator and/or Driver surveys. As far as possible, the basis is on a before-and-after comparison of the implementation of AEOLIX at the living lab and compared to available target values when relevant.

5.1. LL1 Operational Impacts Assessment

Living Lab 1 (LL1) is part of intermodal hub labs groups. To understand assessment on impacts of LL1, it is better to outline the operational setup for AEOLIX and the two supply chain scenarios:

- **LL1 Scenario 1: Logistics Hub Hamburg, incl. Hub2Hub Hamburg – Frankfurt**
- **LL1 Scenario 2: Logistics Hub Frankfurt/Rhein-Main**

Based on this setup the overall objectives for such an assessment are defined as:

- Reduce congestions on the terminals and on the access roads to the terminals.
- Fuel consumption and within CO₂ emissions can be reduced up to 20-30% as truck do not need to wait unpredictability long times at terminals and driving more sustainable.
- Multi-modal rail-based transport can become significantly more reliable and attractive to shippers and consignees if the entire multimodal move becomes more efficient, transparent and of reliable performance, enabling also a further shift of demand from road to rail.

Looking at real data exchange between the LL1 components (see D5.4 Implementation report of LL1) beside the defined supply chain processes always the data model of the 'Train Loading List' has been taken into account for LL1. Finally the predefined KPIs for LL1 (see Table 1) and this additional step to cover some more KPIs LL1 analyzed the complete list of KPIs and identified some which are analyzed be questionnaires provided to the supply chain stakeholders within LL1.

The LL1 assessment of the overall list of KPI by LL1 is shown in Table 4 below:

Table 4: KPIs assessment by LL1

KPI	Data/Formula for calculation	Assessment
KPI_1: Average fuel consumption	FC [l/km], FC-1 [km/l]	To be calculated by ECO Trans IT and LCMM.
KPI_2: Average number of trips with consolidated cargo	no of trips with consolidated cargo / time unit, htrips cargo [%]	no information concerning consolidation available for LL1
KPI_3: % of Empty runs	% of total veh-kms which are run empty, hdistance empty [%] % of total veh-hrs which are run empty, htime empty [%]	Trains always runs complete Huge vehicle always runs with one complete container, no optimization regarding empty transport spaces possible.
KPI_4: Average waiting time	Waiting time twait [h] Waiting time, ratio, ht, wait [%]	Not explicitly covered by the ,Train Loading List 'data, to be analyzed by a questionnaire.
KPI_5: Average loading/unloading time	Activity time, tloading, tunloading [h] Activity time, ratio, hloading, hunloading [%]	Not explicitly covered by the ,Train Loading List 'data, to be analyzed by a questionnaire.
KPI_6: Terminal Productivity	Gate throughput, Fgate [load units/h] Load unit time in terminal, tterminal Load unit = trailer, truck, rail car etc.	Not explicitly covered by the ,Train Loading List 'data, to be analyzed by a questionnaire.
KPI_7: % of Load factor	Load factor, LF [%], Utilised capacity, Lused / Available capacity, Lavailable	Not explicitly covered by the ,Train Loading List 'data, to be analyzed by a questionnaire.
KPI_8: Average CO2 emissions	CO2Eq [g/l], expressed as a function of fuel amount	To be calculated by ECO Trans IT and LCMM see also KPI 1
KPI_9: Administration work	minutes, hours	no information for LL1 available
KPI_10: Traffic avoidance/congestion reduction	Driving time (in hours or minutes) distance spent in congestion (in kilometers) relative to the total travel time (in hours or minutes) distance (in kilometers)	no information for LL1 available
KPI_11: Level of service	Customer satisfaction for AEOLIX services	no information for LL1 available
KPI_12: Modal shift	difference in % of cargo transported by rail or vessel (not by truck) over total cargo transported	no information for LL1 available
KPI_13: Custom Procedures	time needed to execute customs processes in minutes	no information for LL1 available
KPI_14: Visibility / data sharing	delivery arrived full (yes/no) Delivery arrived on time (yes/no, if no also delay in hours or minutes)	no information for LL1 available
KPI_15: Interoperability	data latency or quality of exchange or time of interoperation)	Not covered by LL1 data, to be analyzed by a questionnaire.
KPI_16: Financial benefits	% of reduced costs	Not covered by LL1 data, to be analyzed by a questionnaire.
KPI_17: Dynamic reconfiguration of shipments	% of reconfigured shipments / total shipments	no information for LL1 available

KPI_18: Terminal handling efficiency	total number of containers handled per day	Not covered by LL1 data, to be analyzed by a questionnaire.
KPI_19: Reliability / Risks (Reliability of equipment)	mean time between failure (eg. Increase >10% / year)	Theme for predictive analytics/maintenance No information available
KPI_20: Standardization	% of Automated reporting	no information for LL1 available
KPI_21: Acceptance and trust (degree of approval of a technology by the user)	Usefulness Usability Perceived level of usability Perceived system consequences	Not covered by LL1 data, to be analyzed by a questionnaire.

Concerning the impact of fuel consumption and CO2 emissions the following approach has been setup:

Fuel consumption:

KPI record the values used to estimate mileage and associated fuel cost for a specific vehicle. There are two sources of input which can be used to evaluate the fuel consumption:

- EcoTransIT reference values comparing the different modes of transport relevant for this Living Lab, i.e. road and rail. AEOLIX will calculate the road and rail transport emissions along the Frankfurt-Hamburg corridor as well as the road transport of the last mile in both hubs (Frankfurt / Hamburg).
- Low Carbon Mobility Management (LCMM), based on GPS speed profiles.

KPI assessment:

EcoTransIT reference values are listed in table below as can be found in the Internet. As one can see, fuel consumption is linked directly to payload. For a 12t-Truck, a range of 19 to 24 liters per 100km increase is published by the EcoTransIT tool.

Here an example for urban logistics of a 12-ton truck:

- Fuel consumption for a full 12t-truck is 40 l/100km inner-urban,
- Fuel consumption for a full 12t-truck is 20 l/100km extra-urban,
- Fuel consumption for a full 12t-truck is 19 l/100km with 90 km/h constant.

This calculation is based on the energy equation for fuel consumption is stated in Figure 3 below:

$$\Phi(v) = \eta b_e \frac{\int_0^T (F_{acc} + F_{brake} + F_{roll} + F_{air} + F_G) v(1s) dt}{\int_0^{T'} v(1s) dt}$$

$$F_{acc} = m \cdot \frac{dv}{dt}, dv > 0$$

$$F_{brake} = \beta m \cdot \frac{dv}{dt}, dv < 0$$

$$F_{air} = \frac{\rho}{2} \cdot A \cdot c_w v^2$$

$$F_{roll} = mg\mu$$

$$F_G = mg \cdot \sin(\alpha)$$

η – Wirkungsgrad, b_e – Brennwert in MJ/Liter
 m – Gesamtgewicht, v – Geschwindigkeit, β – Vortrieb
 μ – Reibungskoeffizient, g – Erdbeschleunigung
 ρ – Luftwiderstand, A – Querschnittsflaeche, c_w – Luftwiderstandsbeiwert
 α – Steigungswinkel

Figure 3: Energy equation based on Newtonian Physics of Driving

Here all elements of energy are listed, including braking and acceleration. With the vehicle configuration standard parameters, one finds the set of solutions from (a) to (c).

As shown in the above example, the level of aggregation in CO₂ calculation tools is too high compared to the statistical deviations which result from urban and extra-urban traffic conditions. This includes traffic congestions, standstill and acceleration (braking) behavior as well as mountain influences.

To set up a reliable baseline estimation, LL1 arranged the following approach:

- Use EcoTransIT for standard container volume on TX trains from Hamburg to Frankfurt (M),
- Consider the load factor (e.g. 60%) based on standard logistics KPI on average,
- Take data from the Frankfurt region showing the influence and the deviation of speed and fuel consumption due to traffic,
- Translate fuel consumption to CO₂ emissions to estimate statistical deviations relative to the EcoTransIT calculation method,
- Include the statistical deviation into the calibration process to improve quality of EcoTransIT calculus.

Table 22 Energy consumption and emissions of trucks with different load 1 Europe (Euro V, motorway, average gradient for hilly countries)

Truck type	Unit	Full 100%	Average 50%	Empty 0%
Energy consumption				
Truck <=7.5t	l/100km	14,4	13,7	13,0
Truck >7.5-12t	l/100km	20,0	18,5	16,9
Truck >12-24t	l/100km	23,5	21,5	19,3
Truck >24-40t	l/100km	37,1	30,2	22,7
Truck >40-60t	l/100km	52,3	40,4	27,1
Truck <=7.5t	MJ/km	5,2	4,9	4,6
Truck >7.5-12t	MJ/km	7,2	6,6	6,0
Truck >12-24t	MJ/km	8,4	7,7	6,9
Truck >24-40t	MJ/km	13,3	10,8	8,1
Truck >40-60t	MJ/km	18,7	14,4	9,7
Truck <=7.5t	g/km	120	114	108
Truck >7.5-12t	g/km	167	154	140
Truck >12-24t	g/km	196	179	161
Truck >24-40t	g/km	309	251	189
Truck >40-60t	g/km	435	336	226
CO₂				
Truck <=7.5t	g/km	381	363	344
Truck >7.5-12t	g/km	530	490	446
Truck >12-24t	g/km	623	569	512
Truck >24-40t	g/km	982	799	601
Truck >40-60t	g/km	1'384	1'068	718

Figure 4: Reference values used in Modal Shift calculus by Logistics Service Providers

As sustainability reports state energy consumption and CO₂ related to financial operations, including fleet composition, fuel consumption and transported payload per time (year, month, week), LL1 baseline evaluation has a focus on EcoTransIT usage.

This is done well knowing that sustainability reports of TX Logistik and other companies use their financial reporting systems on group level to calculate total emissions. This is not possible when analyzing just one single train connection, for LL1 this is Frankfurt to Hamburg, therefore the calibration of calculation methods is very important to establish a strategic tool to reduce emissions on group level by cutting down emissions on local level. This is shown in Figure 4 above.

Figure 5 shows the various levels of aggregation which are of relevance for the sustainability reports. It also shows how difficult it is to transfer emission reduction targets to operational and tactical levels given the number of parameters given in Figure 4.

The Gaussian distribution is added to represent the statistical spread depending on the level of aggregation used in climate calculus. It becomes obvious how difficult it is to shift the CO₂ emissions when it comes to the 3rd level of emission sources where a wide spread parameters and psychological behavior begin to influence the energy balance of the vehicle.

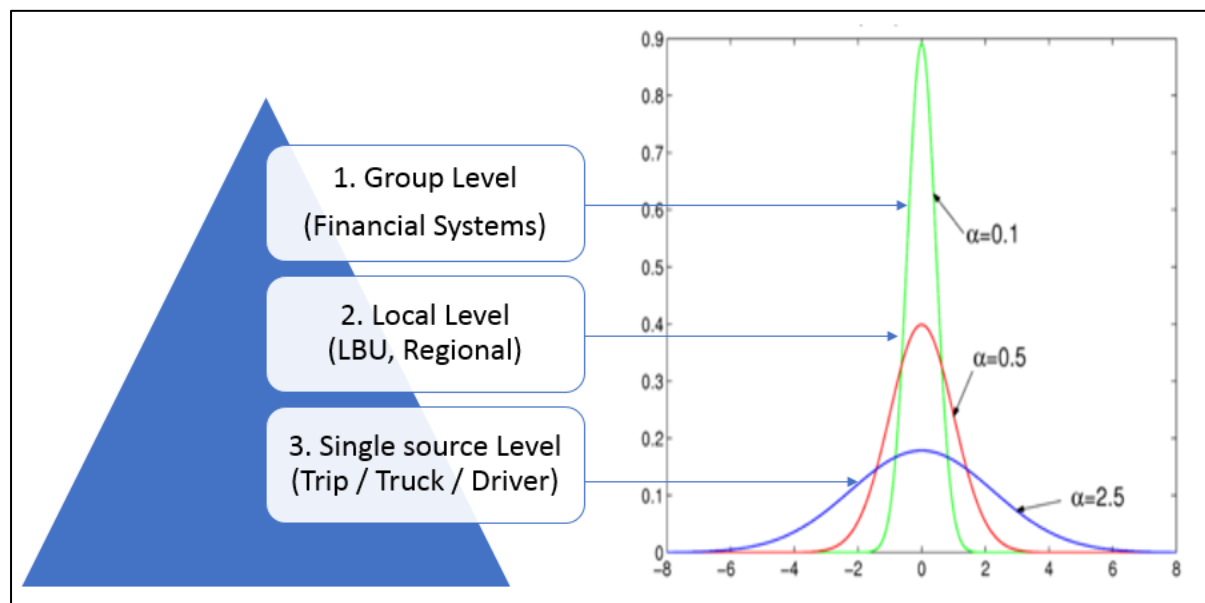


Figure 5: Level of Aggregation for emission calculations

In AEOLIX LL1 baseline studies, only Level 2 and Level 3 are under examination as pilot sites focus on the analysis of emission sources along the sites rather than on Group Level. Nevertheless, the LL1 baseline termination considers aggregated emissions from several sources available for the emission baseline. The calculus then makes some general assumptions from literature given an outline how AEOLIX can achieve reduction targets.

Results concerning fuel consumption and CO₂ emissions of LL1:

Average Fuel Consumption

KPI_1: Average fuel consumption	FC [l/km], FC-1 [km/l]
Baseline assumption:	
One single TX train from Hamburg to Frankfurt transports 33 trailer (40 feet) within an average of 23 tons net payload for each single container.	
A truck with 23 tons of payload is assumed to have >20ton empty vehicle weight, which leads to 37 liters per 100km, see table 22 of EcoTransIT.	

Thus, a total number of 1221 liter of fuel is needed for transporting all goods from the train station to 100km of Hinterland destination.

The TX train needs additional 215 liter of diesel per 100km, which gives a total need of 1435 diesel equivalent liters per 100km.

Operational assumption:

Train data base:

- 20-30 trains/month = max. 1 train/day
- Train length differs due to weight restriction, avg. 600 m.
- Weight mandatory depending on traveled route (load capacity bridges, etc.), usual value: 1600t/train
- Num. containers dep. of length (and therefore weight); usual acceptance 90 TEU or 33 trailers

Energy consumption values large variation depending on route profile (inclines) and weight and possibly driving profile (number of stops / acceleration).

Average energy consumption (based on actual values) for a 1.600 ton train: 10716 kWh to 500km

Emission values cannot be calculated directly, to be determined for transport by train using <https://www.ecotransit.org/calculation.de>

Truck data base: (hinterland transport by truck)

- 1 container by truck (40 feet container) with one trailer or up to 2 TEU (20 feet container) with esp. trailer for each TEU
- TEU (20 feet): Net Weight: 2.4 tons, Gross Weight: 24 tons, payload 21.6 tons
- 40 feet: Net Weight: 4 tons, Gross Weight: 30.5 tons, payload 26.5 tons
- Avg. payload (TXL): 23 tons/40 feet container, TEU 18.5 tons/TEU

Emission values to be determined for transport by truck using LCMM (CO2 Calculation based on Low Carbon Mobility Management by T-Systems).

Speed class km	# trips	Avg. Distance	sum distance km	DistVar	AeroECE	AccECE	STSECE	GradeWork	Avg. Fuel l/100 km	AeroVar	AccVar	STSVVar	GradeVar	FuelVar	EcoTransIT l/100km	deviation l/100km
0-9.9	188	44	8301	36	108	111	250	36	47	70	62	21	11	11	37,1	9,9
10-19.9	477	78	37632	55	105	128	206	38	38	53	48	28	11	11	37,1	0,9
20-29.9	377	121	45869	79	98	122	164	42	33	50	42	35	10	8	37,1	-4,1
30.39.9	246	145	35842	122	96	120	128	39	31	38	41	43	9	9	37,1	-6,1
40-49.9	172	235	40568	199	108	116	100	39	29	43	46	43	10	11	37,1	-8,1
50.59.9	150	307	46056	222	110	106	88	38	29	45	49	34	10	10	37,1	-8,1
60-69.9	110	276	30430	230	102	110	66	37	28	47	56	42	10	10	37,1	-9,1
70-70.9	78	140	10969	108	99	106	49	30	29	49	51	43	8	11	37,1	-8,1
80-89.9	22	110	2436	104	135	134	55	23	29	87	101	86	18	26	37,1	-8,1

Table 5: LL1 operational vehicle trips - speed class results

The analysis base on > 1800 trips of huge vehicles defined above, considering parameters acceleration work, grade work, aero work and standstill work. Trips have been assigned to speed classes (0-9.9, 10-

19.9, 20-29.9, 30-39.9, 40-49.9, 50-59.9, 60-69.9, 70-79.9, 80-89.9) and the fuel consumption per speed class have been calculated.

In comparison with EcotransIT figures of the vehicle weight class > 24-40 tons it is obvious that there are substantial differences between EcoTransIT and the defined speed class figures.

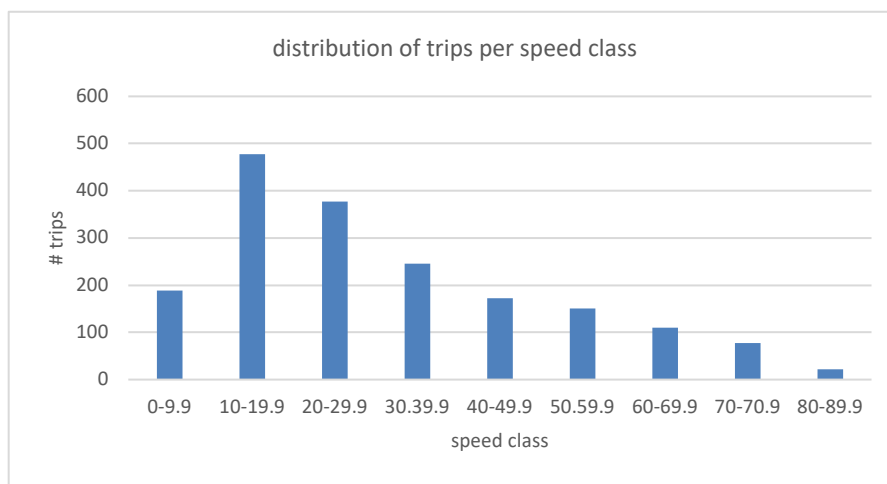


Figure 6: Distribution of truck trips per speed class

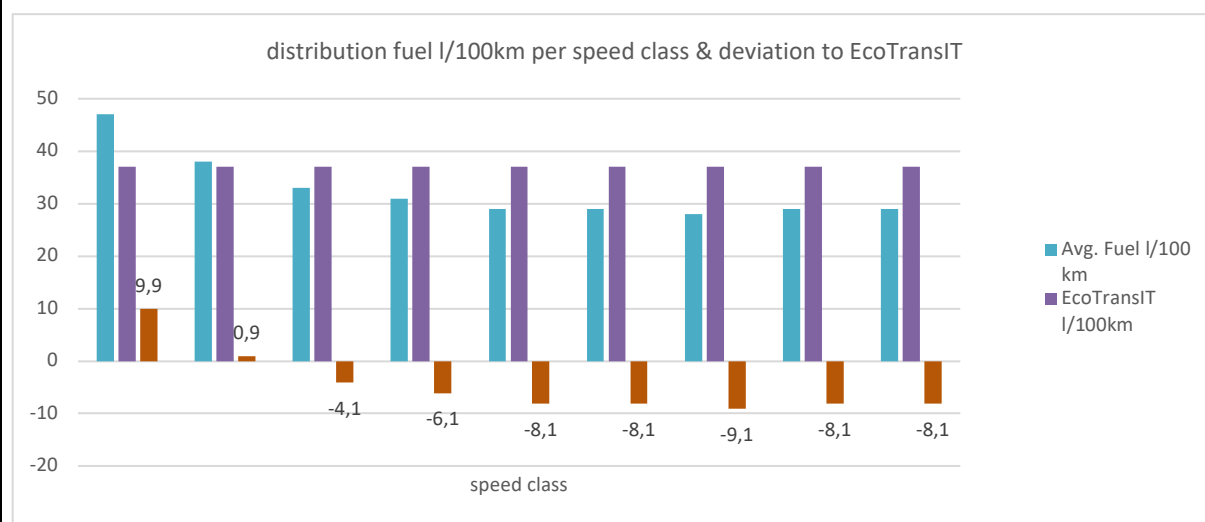


Figure 7: Distribution of Fuel per speed class and deviation to EcoTransIT

For train fuel consumption are no different values as for baseline available due to the fact that a train running from Hamburg port to Frankfurt always has the same parameters as 1.600 tons weight, number of containers or trip distance for each single trip.

Validation result:

To summarize the validation results for container transport from Hamburg port terminal to Frankfurt terminal and the Hinterland transport to destination LL1 can state:

- *The fuel consumption for trucks have been reduced from baseline to operational from 37,1*

liter/100 km to 32,6 liter/100 km which defines a reduction of **12,25 %**.

- The fuel consumption for trains defines no difference for baseline and operation due to equal train parameters.

KPI_8 Avg. Avg. CO2 Emissions:

KPI_8: Average CO2 emissions

CO2Eq [g/l], expressed as a function of fuel amount

Due to direct relation between energy consumption emissions can be calculated by formula. Therefore, see also KPI Avg. Fuel. For energy and emission calculation see e.g. <https://www.unitjuggler.com/convert-fuelconsumption-from-lper100km-to-gperkmdiesel.html> or <https://www.fleetnews.co.uk/costs/carbon-footprint-calculator/>

Baseline assumption:

Based on KPI_1 Avg. Fuel Consumption the calculation for baseline is defined as:

For trucks therefore based on an average fuel consumption of 37,1 liters the average CO2 result is 98,3 kg/100km.

For trains therefore based on the average fuel consumption of 1435 liters the average CO2 result is 3760 kg/100km.

Operational assumption:

Based on KPI_1 Avg. Fuel Consumption the calculation for operation is defined as:

For trucks therefore based on an average fuel consumption of 32,6 liters the average CO2 result is 86,3 kg/100km.

For trains therefore based on the average fuel consumption of 1435 liters the average CO2 result is 3760 kg/100km.

Considered the overall distance within each speed class, the % deviation is shown in Figure 8 below:

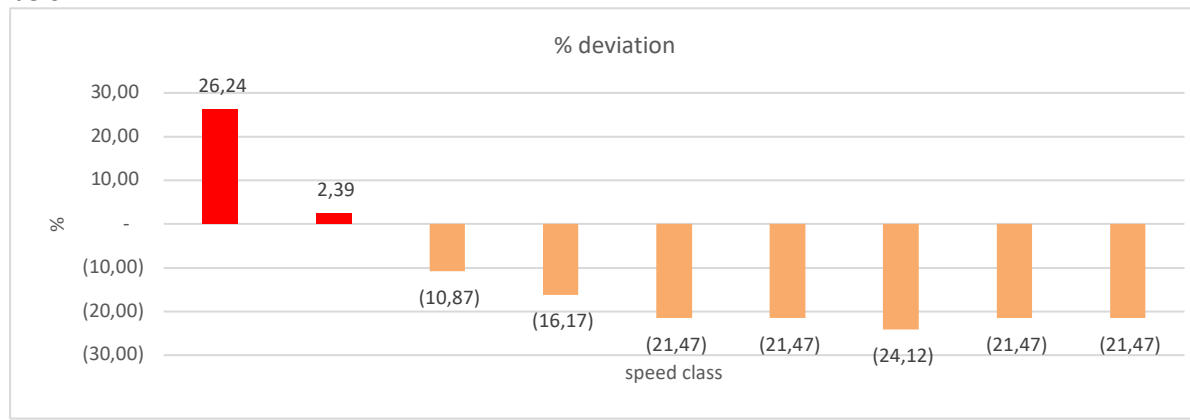


Figure 8: % deviation EcoTransIT vs validated speed class calculation

The overall deviation EcoTransIT calculated emission to validated trips incl. overall distance by classes is 14,4 %. Therefore, the EcoTransIT calculation should be calibrated by speed classes as defined above.

Validation results:

To summarize the validation results for container transport from Hamburg port terminal to Frankfurt terminal and the Hinterland transport to final destination LL1 can state:

- *The average CO2 emission for trucks have been reduced from baseline to operational from **98,3 kg/100 km** to **86,3 kg/100 km** which defines a reduction of **12,25 %**.*
- *Considered the speed class approach and the overall distance the reduction on emission for LL1 **14,4 %**.*
- *The fuel consumption for trains defines no difference for baseline and operation due to equal train parameters.*

5.1.1. LL1 Business Aspects

Business Aspects were mainly evaluated in terms of reduced operational costs, but also in terms of specific performances in relation to target improvement values (expected benefit levels of implementing AEOLIX at the LL). The results are given only for aspects that have been reported by the LL1 and are presented in Table 6 below:

Table 6: Summary of LL1 business aspects

Business impacts LL1	Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
<i>Reduction in fuel consumption (l/km; km/l; or l/tkm)</i>	n/a	37,1	32,6	-12,25%	see above for detailed information
<i>Reduction of waiting time for trucks in the terminal (hrs)</i>	35-40%			22,22%	For what it concerns the average waiting time, a saving of up to 20.000€ can be estimated in LL1. In fact, thanks to the optimization of information, a truck company can save 5 minutes for each operation (40€ per hour is considered as a cost for truck driver).
<i>Increase of terminal productivity (hrs)</i>	15-40%				According to LL1 estimation, 2,5 hours can be saved per train. Considering 150 trains per year, 375 hours could be saved in one year. If 60 € per hour – the cost of the

					worker – is considered, the total benefits would be 22.500€.
<i>Terminal Handling Efficiency</i>					The terminal handling efficiency should have also an important influence in LL1. The estimation from LL1 reveal that 10.000€ per year can be saved (considering a saving of 2,5 minutes per each shunter operation and 40€ as the cost of the worker per hour).
<i>Administrative Work</i>					For LL1, the administrative work can decrease. It has been estimated that about 3 minutes of work can be saved for each container. 90 containers per each train, per 150 trains, per 3 minutes saving (60€ cost of the back office employee per hour) are considered, LL1 can assess the value of a financial benefit up to 40.500€. This value base on the assumption that all related supply chain stakeholders for the LL1 scenarios will be taken into account (like terminal operators, shunter, train operators and truck companies).
<i>Financial Benefits</i>					The TX dispatcher checks container status via AEOLIX instead of direct access with other systems or classic approaches like telephone, Fax or Emails. This change allows to save 9.180€ per year, considering around 150 trains with 90 containers each train.
<i>Reduction in average CO₂ emission (g/km; l/tkm)</i>	<i>Up to 20%</i>	<i>98,3</i>	<i>86,3</i>	<i>-14,44%</i>	According to the fuel consumption (KPI_1: Fuel Consumption) LL1 estimated that approx. 53.000 liter of saved fuel 140 tons of CO2 emissions will not be emitted and no CO2 certificates are needed. Based on a price of 180€ per CO2 ton approx. 25.000 € benefits can be added. Detailed information see above

Based on the KPIs, following

Table 7 present summary of costs savings for living lab1:

Table 7: LL1 financial benefit summary

LL1 Financial Benefits

KPI_1: Average Fuel Consumption	68.757 €
KPI_4: Average Waiting Time	20.000 €
KPI_6: Terminal Productivity	22.500 €
KPI_8: CO2 emissions Saving	25.000 €
KPI_9: Administrative Work	40.500 €
KPI_16: Financial Benefits	9.180 €
KPI_18: Terminal Handling Efficiency	10.000 €
Total Benefits	195.937 €

5.1.2. LL1 Socio-economic Aspects

Socio-Economic Impacts are evaluated in terms of impacts on Job Creation, SME empowerment, and Quality of Life. However, no data is available on these aspects of socio-economic impact due to relationship with other stakeholders in living lab 1. That is, the stakeholders are not willing to share data due to privacy issues.

5.1.3. AEOLIX Acceptance and Trust at LL1

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance.

The study asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 9 shows the usefulness of Dashboard, Connectivity engine and toolkit services as expected by LL1 evaluation manager before AEOLIX.

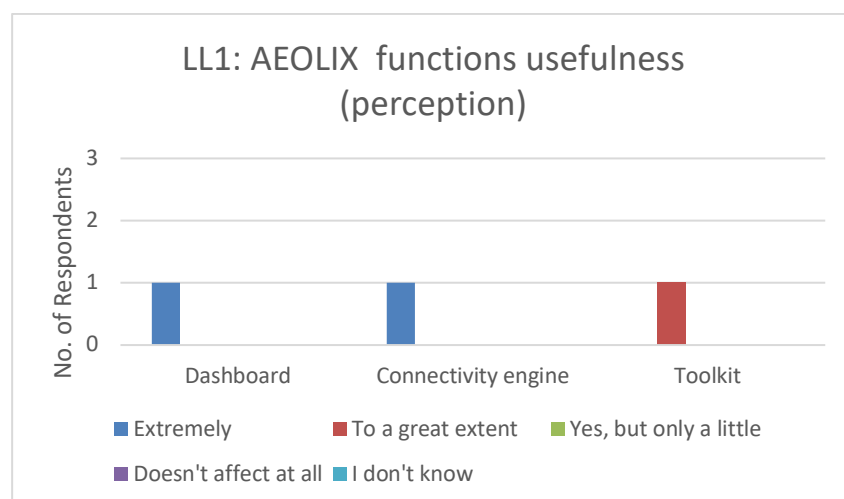


Figure 9: AEOLIX functions usefulness (perception) at LL1

Dashboard and connectivity engines were considered to be ‘extremely’ useful before AEOLIX. While toolkit was perceived as useful ‘to a great extent’.

Following Figure 10 shows the experiences after using AEOLIX. This clear that Dashboard that was considered to be extremely useful, proved to be useful ‘but only a little’.

However, connectivity engine met its expectation and proved to be extremely useful. Similarly, toolkit services met its perception of being useful ‘to a great extent’.

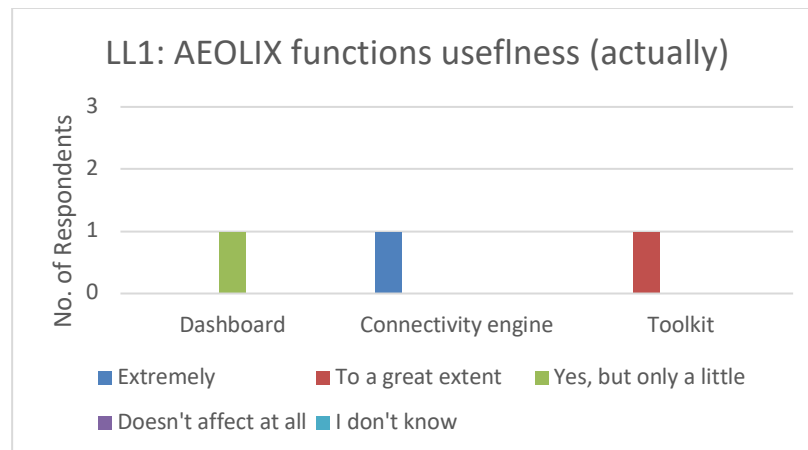


Figure 10: AEOLIX functions usefulness (actual) at LL1

Based on the above varied results, it can be interpreted that the acceptance and trust on AEOLIX is medium, since the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system.

The study continued to ask questions about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users shows interest ‘To a great extent’ on willingness to continue using connectivity engine and toolkit services. However, LL1 did not find the current Dashboard implementation to be very useful and only willing ‘to a little extent’ to continue using it. Following Figure 11 shows summary of users willingness to continue using AEOLIX.

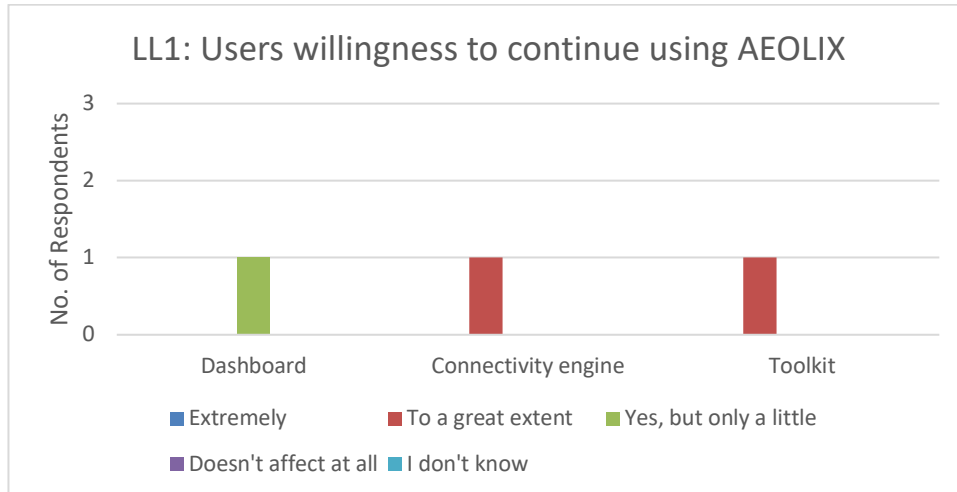


Figure 11: Users willingness to continue using AEOLIX at LL1

After willingness to continue using AEOLIX, we asked questions about trust on various components:

To what extent, users trust on various AEOLIX functions?

The results show that LL1 users trust varies across different function. They trust connectivity engine and toolkit services 'to a great extent'. But they do not have much good experience or faith on the functionality and usefulness of AEOLIX Dashboard because it was not deployed or used operationally. Following Figure 12 shows a summary of responses for users trust on AEOLIX functions at LL1:

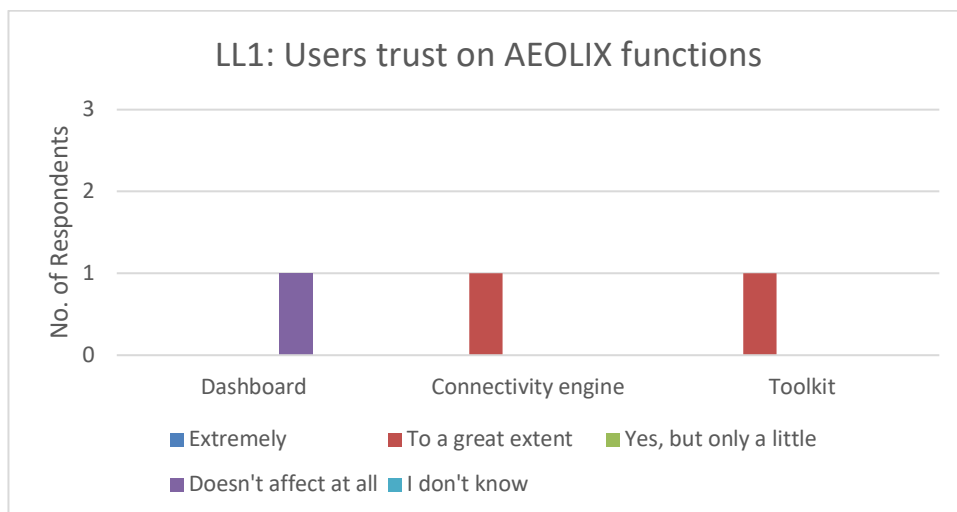


Figure 12: Users trust on AEOLIX functions at LL1

On the basis of above analysis, a conclusion can be drawn that LL1 accept and trust connectivity engine and toolkit services to a great extent. However, the acceptance and trust level for Dashboard is achieved average ratings for the living lab.

5.2. LL2 Operational Impacts Assessment

Living Lab 2 (LL2), also known as Termilab Gothenburg, is an example of intelligent hub labs. This living lab is focused on a trailer terminal for cross-docking where a forwarder, NTEX, operates a network of terminals with their own trailers. The transportation capacity is supplied by haulage companies (subcontractors). The main problem that we are addressing in this living lab is how to exploit real-time dynamic data and information related to the resources in the system, not only the cargo. A trailer in need of service, for instance, will effectively cripple the operation of a forwarder if not fixed in time. The same also applies to handling equipment, trucks and load securing. In TermiLab, we will implement innovative data collection methods aimed at digitizing this often hard to define information so that it can be valorized by actors in the supply chain by making it part of the AEOLIX eco-system. LL2 is looking forward to meet some long term benefits with AEOLIX which are as follows:

- Significantly reduced waste in terms of waiting times, cost of malfunctioning or missing equipment, missing span sets etc.
- Lower CO2-footprint due to more efficient transport operation with less waiting times and more actionable information when making decisions.

This study got responses from managers from three companies – Gothenburg port, Oslo port and NTEX. Gothenburg port has 7, Oslo 10 and NTEX has 36 employees as shown in Figure 13 below:

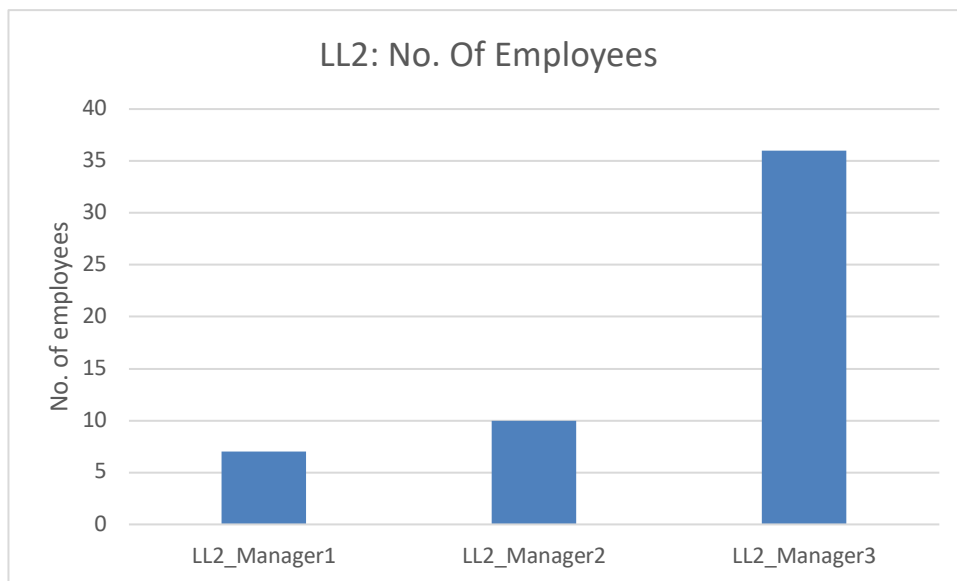


Figure 13: Number of employees at respondent companies within LL2

The average experience of employees at Gothenburg and Oslo ports is more than 6 years, and at NTEX is 2-3 years. This means the respondents have considerable amount of experience within the industry and their responses can be taken as expert opinions.

These companies and ports plays different roles in supply chain including:

- Forwarder
- Logistics service provider
- Logistic operator
- Carrier
- Cargo operator
- Custom operator
- Fleet and transport operator

Both ports, at Gothenburg and Oslo, owns about 700 semi-trailers. While all three companies within LL2 cover urban and rural areas on domestic and international levels. The types of goods and products these companies deal with include the followings:

- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
- Transport equipment
- Furniture; other manufacturing goods n.e.c.
- Equipment and material utilized in the transport of goods
- Grouped goods: a mixture of types of goods which are transported together
- Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16
- Other goods

Moreover, Gothenburg and Oslo ports deals with road freight only including

- Palletized goods
- Other freight containers
- Other cargo units not elsewhere specified

On the other hand, NTEX deals with both road and sea freights. Their road freight includes

- Large freight containers
- Palletized goods
- Other freight containers

And sea freight includes the followings

- Dry bulk
- Containers
- Ro-Ro units (wheeled vehicles that be loaded and discharged without cranes)

The analysis of the results show that living lab 2 (Termilab Gothenburg) has implemented AEOLIX solution. To evaluate the implementation impacts for LL2, we collected the list of KPIs measured and provided by LL2 evaluation manager. The list of KPIs as measured by LL2 includes:

- Average number of trips with consolidated cargo
- Average waiting time
- % of load factors
- Administration work
- Custom procedures
- Visibility / data sharing
- Dynamic reconfiguration of shipments
- Terminal handling efficiency
- Acceptance and trust

Before going into the details on AEOLIX impacts within LL2, this report provides a summary of service is provided below together with the description of how various KPIs are related to the service:

Trailer Status

This service tells us the status of the trailer, when unloaded or loaded at the port and is shown in Table 8 below:

Table 8: KPIs contributing to trailer status at LL2

KPIs	Description of KPIs (i.e. how specific KPIs contributed to trailer status)
KPI_4: Average waiting time	Waiting time can be measured with help of GPS data, not directly the service data.
KPI_5: Average loading / unloading time	The service gives exact time of unloading and loading
KPI_6: Terminal productivity	The service gives exact time of unloading and loading
KPI_18: Terminal handling efficiency	Data on the terminal effectivity is available as the service takes into account all loading and unloading activities

5.2.1. LL2 Business Aspects

The analysis of the material shows that no numerical business impact KPIs have been reported to which analysis can be applied at LL2 level. Below is the response on the selected KPIs at LL2:

Average Number of Trips with Consolidated Cargo

The average number is about 80%. This has not changed yet but will probably in the future when the forwarding function of the company is using the system on daily bases.

Average Waiting Time

The measurement has not shown any significant changes in waiting time. The focus of the system has been terminal efficiency, and the transport companies are not included yet.



Average Loading/Unloading Time

The unloading time hasn't changed much. There is still a saving in preparation and put-away time when forklift trucks travel between unloading dock and storage position.

Terminal Productivity

It has changes considerable, both in preparation of truck coming in and leaving as well as preparing unloading and loading. 150 000 Euro/year.

Administration Work

By digitation, many paper documents have been eliminated and fetching and using printed material disappeared. By digitalization of the terminal planning and operations, administration of loading and unloading has been improved.

Visibility / Data Sharing

Shipments data (orders) are visible internally to NTEX forwarding unit and the terminal operators and will be in the future to external operators. Access to shipments data, unloading and loading assignments much easier to see due to the data sharing capabilities.

Terminal Handling Efficiency

Preparation for loading and unloading become much easier with the use of AEOLIX at LL2. However, some data on business impacts in terms of reduction in time spent for various activities was made available by NTEX manager. The company has reported positive impacts in terms of saving hours with the use of AEOLIX during various activities. A summary of those activities along with the impacts is provided in the

Table 9 below:

Table 9: Summary of terminal handling efficiency at LL2

Activity	Before AEOLIX (Time)	After AEOLIX (Time)	% Increase of decrease
Manually sorting and handling freight letters, as proof of release of cargo	1.5 working hours/day	0	-100%
Making deviation reports. Before it was done manually with camera, uploaded to an e-mail on a computer together with scanned copy of shipping document	Approx. 15 minutes	2-3 minutes	-80%
Make manual hand-written list of "sleep over" cargo 2 times per week	1.5-2 working hours	3-5 minutes	-96%

The results show that AEOLIX has been useful ‘to a great extent’ when it comes to saving time on various activities. For example, the manual sorting and handling freight letters, as a proof of release of cargo is not needed anymore – this is done automatically and saves one and a half hour of every day work. So, 100% of time reduction has been achieved in this case. Similarly, AEOLIX has helped to reduce the time for making manual hand-written list of “sleep over” cargo twice per week from 2 hours to 5 minutes, at the most. This has saved 96% of the time spent on that particular activity. Finally, deviation reports were made manually before AEOLIX costing approximately 15 minutes. This now can be done within 2-3 minutes saving 80% of the time. The results are shown in the Figure 14: AEOLIX impact on time saving at LL2 below as well:

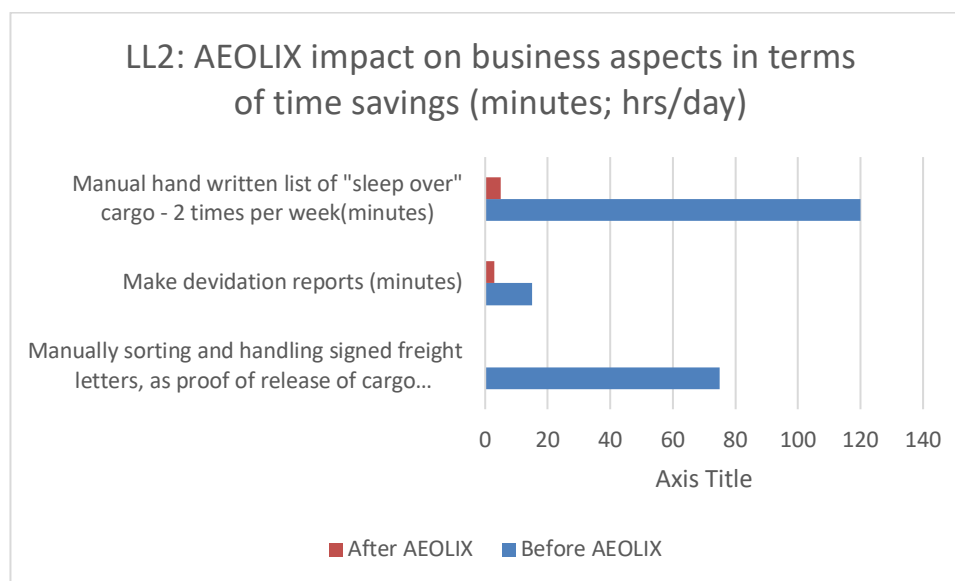


Figure 14: AEOLIX impact on time saving at LL2

These time savings and benefits contribute to the more efficient terminal operations by reducing facilities and labor. Following Table 10 shows one of the major benefit for the cost:

Table 10: Sumamry of financial benefits ahcieved at LL2

LL2	Target value	Before AEOLIX	After AEOLIX	Achived/Estimated Value	Activities (Reasons)
C4. Distribution center operations (through reduction in facilities and labor) - target 3-5%					
Distribution center operations	3-5%	750000	600000	-20%	More efficient terminal operations

This reduction in distribution center operations reduced the cost from 750 000 euros to 600 000 euros which is equal to 20% cost reduction. The target for distribution center operations was set to 3-5%. Therefore, we can say that AEOLIX has provided benefits ‘to a great extent’ for distribution center

operations. This reduction in distribution center operations, before and after AEOLIX, is shown in Figure 15 below.

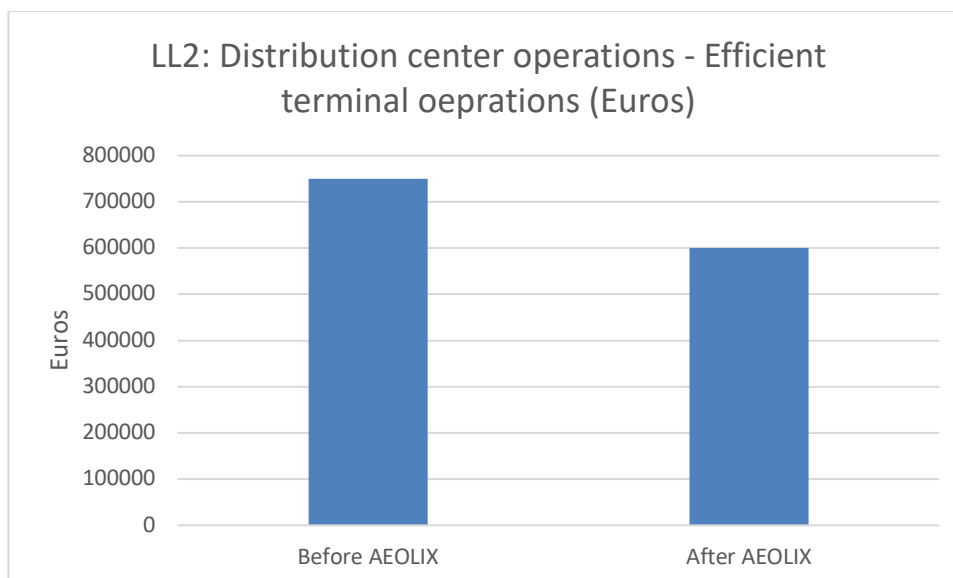


Figure 15: Distribution center operations at LL2 (before & after AEOLIX)

5.2.2. LL2 Environmental Aspects

The analysis of data obtained from companies and users within living lab 2 shows some reflections associated with environmental impacts of AEOLIX implementation as follows:

Reduced CO₂ Emissions

No data available for CO₂ emission.

Noise Pollution

A summary of results is presented in Figure 16 below:

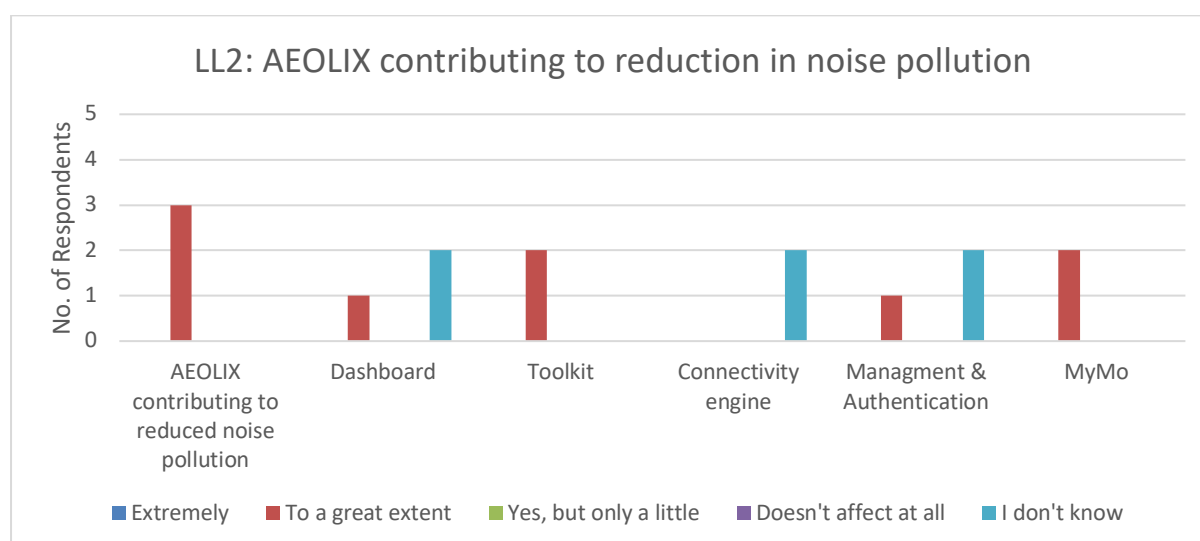


Figure 16: AEOLIX contributing to noise reduction at LL2

All the respondents agree that AEOLIX, in general, has contributed to reduction of noise pollution 'to a great extent' at LL2. However, the contributions made by various AEOLIX functions differs in terms of contributing to reduced noise pollution. The results show that only one respondent think that Dashboard and management functions have helped in reducing noise pollution at his workplace. The rest of the respondents were unaware of the effects of these two functions on reducing noise pollution. Toolkit services, on the other hand, is considered useful 'to a great extent' in reducing noise pollution. While the role of connectivity engine in reducing noise pollution is unknown, a local functionality 'MyMo' at LL2 was considered to be useful 'to a great extent' at reducing noise pollution.

5.2.3. LL2 Socio-economic Aspects

Like others, AEOLIX has impacted various socio-economic aspects. Following paragraphs provides the description of these impacts.

Job Creation

The implementation of AEOLIX solution may create 1-2 operator jobs per year for NTEX. While, AEOLIX does not seem to affect any operator jobs at Gothenburg and Oslo ports. On the other hand, all three company managers think that it will not have any effect on number of jobs for drivers. A summary of results related to AOELIX impact on job creation is presented in Figure 17 below:

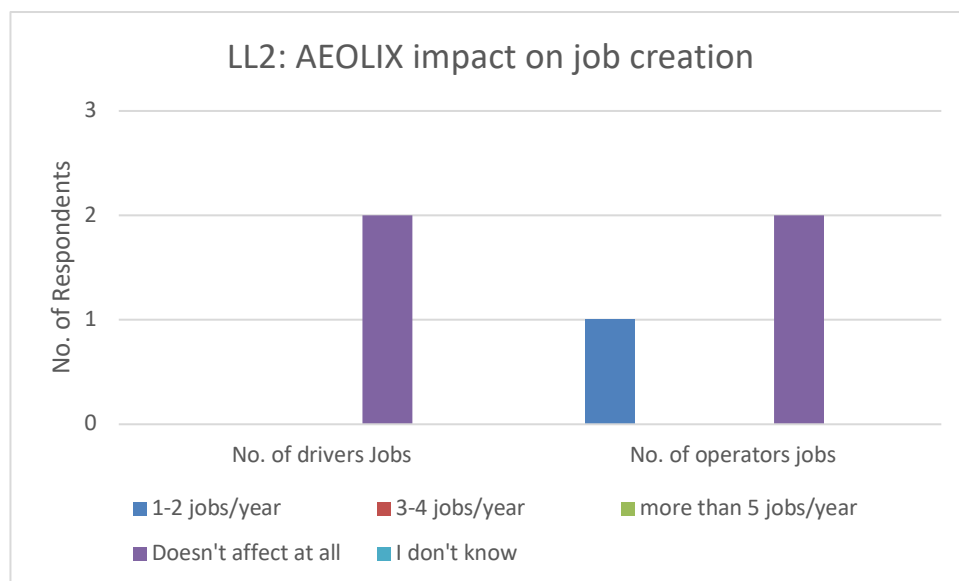


Figure 17: AEOLIX impact on job creation at LL2

SME Empowerment

According to collected material, only one company (NTEX) thinks that there will be only a little impact on SMEs empowerment while this impact is not known to the two ports within LL2. However, this

impact will be realized in terms of 'greater market share'. On the other hand, there are great chances for SMEs empowerment through collaboration with bigger organizations for NTEX management, if they use AEOLIX. Again, Gothenburg and Oslo ports are unaware of the impacts of AEOLIX regarding increased collaboration especially with large organizations. A summary of results is presented in Figure 18 below:

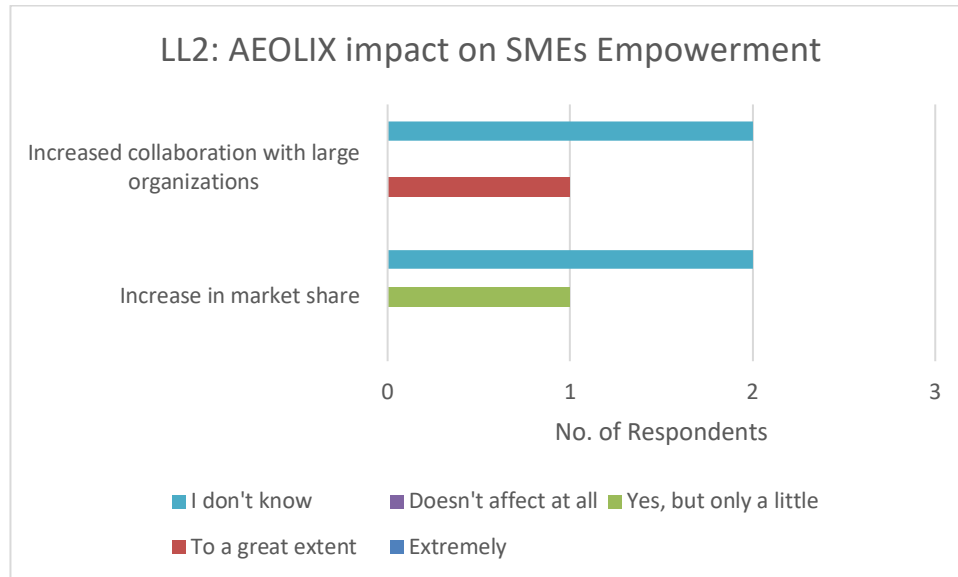


Figure 18: AEOLIX impact on SMEs empowerment at LL2

Improved Quality of Life

No data available

5.2.4. AEOLIX Acceptance and Trust at LL2

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance.

The study asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 19 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL1 evaluation manager. Dashboard and connectivity engines were considered to be useful 'to a great extent' before AEOLIX. While toolkit services has no perception of usefulness, according to LL2 evaluation manager.

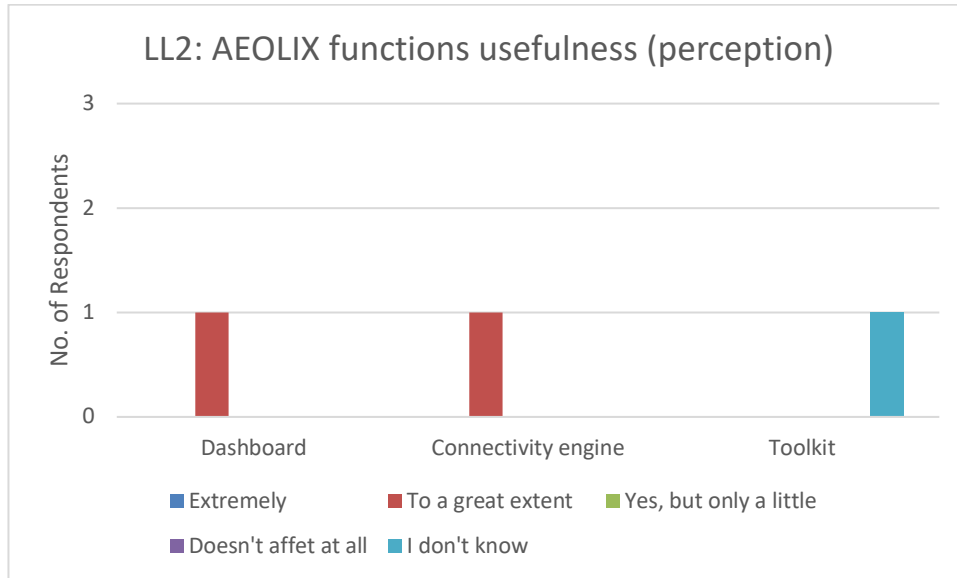


Figure 19: AEOLIX functions usefulness at LL2 (perception before AEOLIX)

Following Figure 20 shows the experiences after using AEOLIX. This clear that Dashboard and connectivity met their expectation of being useful 'to a great extent'. That is, both of the functions were perceived as useful and actually proved to be useful 'to a great extent' at LL2. However, toolkit services usefulness is still unknown for LL2 evaluation manager. A summary results is shown in figure below:

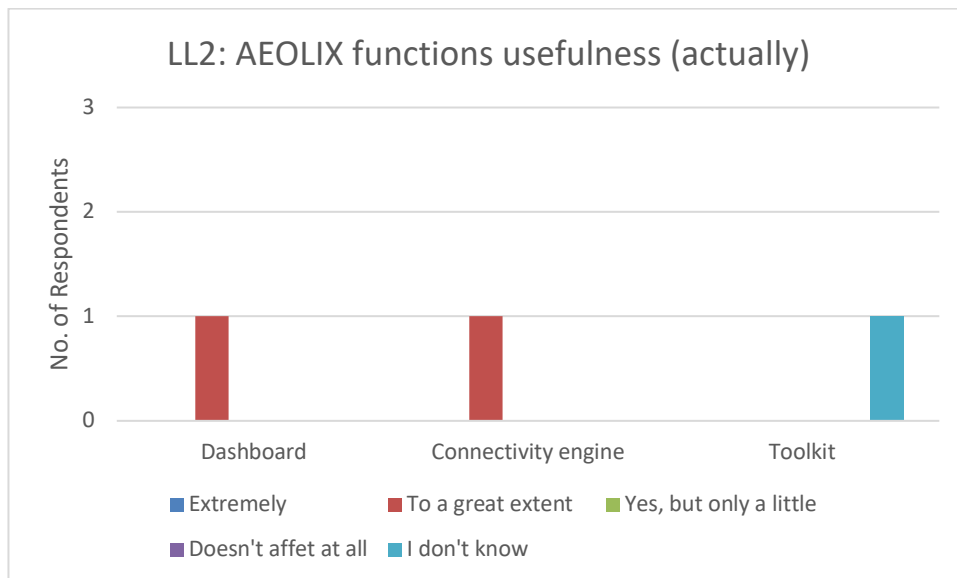


Figure 20: AEOLIX functions usefulness at LL2 (in actual after AEOLIX)

Based on the above varied results for various AEOLIX functions, this can be said that the acceptance and trust on AEOLIX is quite high for Dashboard and connectivity engine. This is because the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system.

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users at LL2 are 'extremely' interested in continue using Dashboard and connectivity engine functions of the AEOLIX. However, they seem eager to try the benefits of toolkit services 'to a great extent as well. Following Figure 21 shows the summary of results:

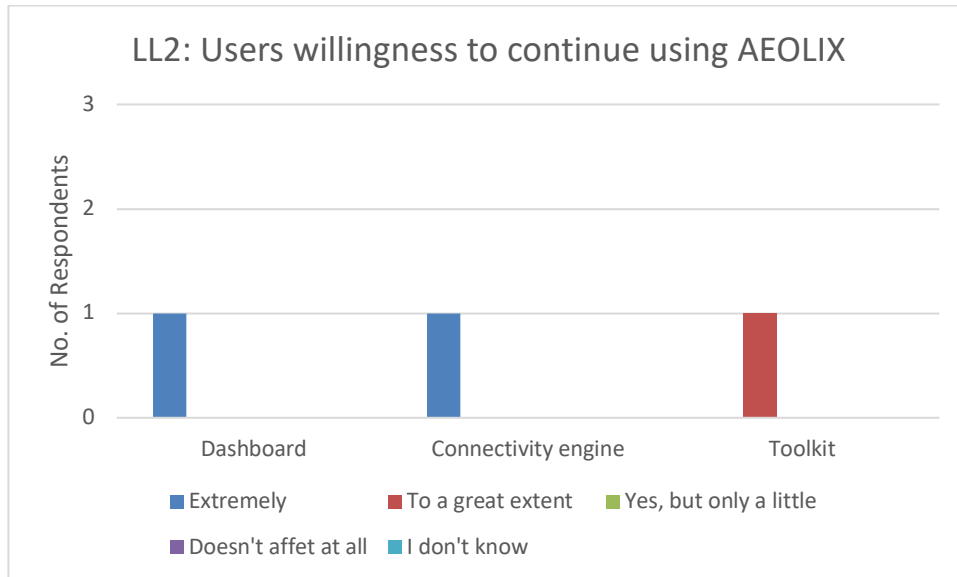


Figure 21: Users willingness to continue using AEOLIX at LL2

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

At the end, LL2 evaluation manager is unaware if various AEOLIX users trust its different functions as shown in Figure 22 below.

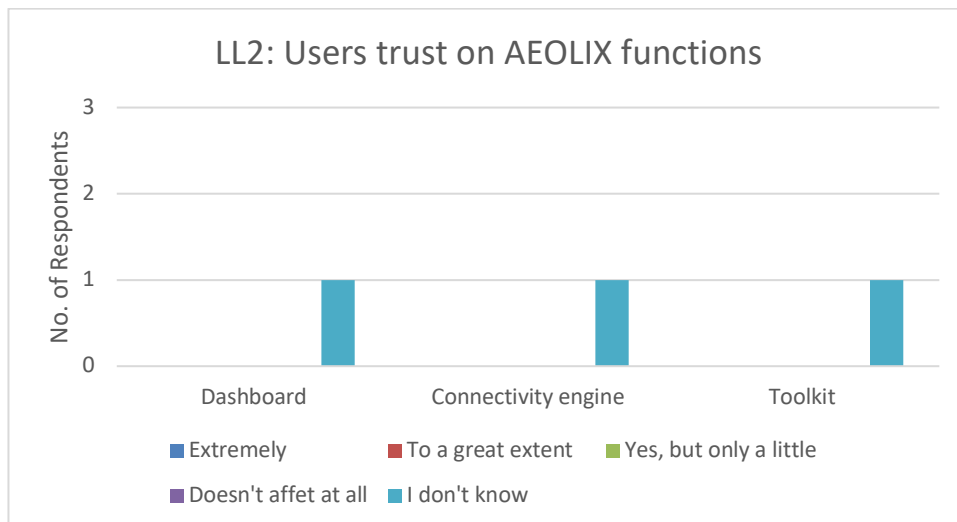


Figure 22: Users trust on AEOLIX functions at LL2

Many aspects of Acceptance and trust remained unanswered in LL2 response diary.

5.3. LL3 Operational Impacts Assessment

LL3 is located in Thessaloniki, a wider area and industrial zone with links along the Pan-European Corridor X and the Orient –East Mediterranean Corridor. It is an important hub for freight and logistics within the Balkans. The living lab has a number of long-term including:

- Reduction of traffic and congestion along the corridor and in the urban node
- Reduction of vehicle kms
- Load Factor increase
- Reduced emissions
- Reduced operational costs for users
- Increased level of Service
- Establishment of an innovative local ecosystem of LSPs and related stakeholders

For operational impact assessment, two managers from PROTO (manager 1) and VIANOX (manager 2) companies responded to the survey. Company 1 has shipper customer or consignee role in supply chain while company 2 is an operator. Company 1 has 22 employees with 5-6 years of average experience while company 2 has 55 employees with more than 6 years of experience. Both companies operate in urban as well as rural areas on international and domestic levels. These areas are covered with help of external partners who own 15 and 45 trucks, respectively. The types of goods or products both companies operates include the followings:

- Products of agriculture, hunting, and forestry; fish and other fishing products
- Coal and lignite; crude petroleum and natural gas
- Metal ores and other mining and quarrying products; peat; uranium and thorium
- Food products, beverages and tobacco
- Textile and textile products; leather and leather products
- Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media
- Coke and refined petroleum products
- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
- Other non-metallic mineral products
- Basic metals; fabricated metal products, except machinery and equipment
- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
- Transport equipment
- Furniture; other manufacturing goods n.e.c.
- Secondary raw material; municipal wastes and other wastes
- Mail, parcels
- Equipment and material utilized in the transport of goods
- Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods n.e.c.
- Grouped goods: a mixture of types of goods which are transported together

- Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16
- Other goods

Furthermore, these products are delivered with the help of road and sea freight modes of transportation including:

- Large freight containers
- Other freight containers
- Palletized goods
- Pre-slung goods
- Mobile, self-propelled units
- Other mobile units
- Other cargo units not elsewhere specified
- Dry bulk
- Containers

LL3 has reported number of KPIs for measuring the reduction in time and usage of resources including:

- Average fuel consumption
- % of empty runs
- % of load factors
- Average CO2 emission
- Administration work
- Level of service
- Visibility / data sharing
- Interoperability
- Financial benefits
- Acceptance and trust

These KPIs impact various aspects related to business, socio-economic, and environmental perspectives. Following figure shows the list of KPIs impacting CO2 emission, reduced operational cost, improved quality of life, SMEs empowerment, and job creation. that reduced operational cost is affected by fuel consumption, empty runs, terminal productivity, load factor, administrative work, visibility or data sharing, and interoperability. Similarly, Carbon footprints are affected by fuel consumption, empty runs and CO2 emission. Improved quality of life is impacted by CO2 emission, level of service, interoperability, visibility on data sharing, and acceptance and trust on AEOLIX. Finally, SMEs empowerment is affected by visibility, interoperability and, acceptance and trust on AEOLIX. An overview is presented in Figure 23 below.

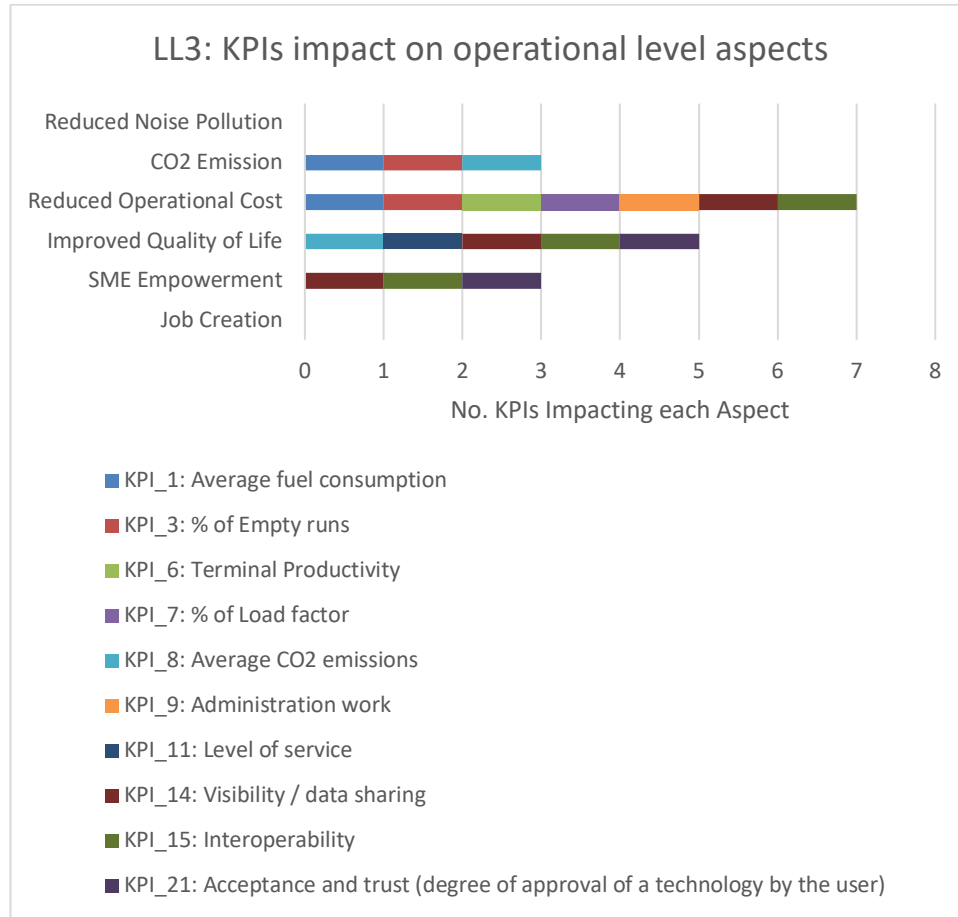


Figure 23: Summary of KPIs impacting various aspects at LL3

In terms of impact, these KPIs can have direct or indirect impact. Furthermore, they can impact on low, medium or high levels. For example, percentage of empty runs have an indirect and medium impact on various aspects at the operational level. Similarly, average fuel consumption has direct and medium impact on various aspects at the operational level. Similar descriptions can be drawn for other KPIs impact level and type.

LL3 has provided quantitative figure for four of the above mentioned KPIs – fuel consumption, load factor, CO₂ emission, and administration work. Following paragraphs provide description on how much AEOLIX could help to improve the situation for the above mentioned KPIs for LL3. A summary is shown in Figure 24 below.

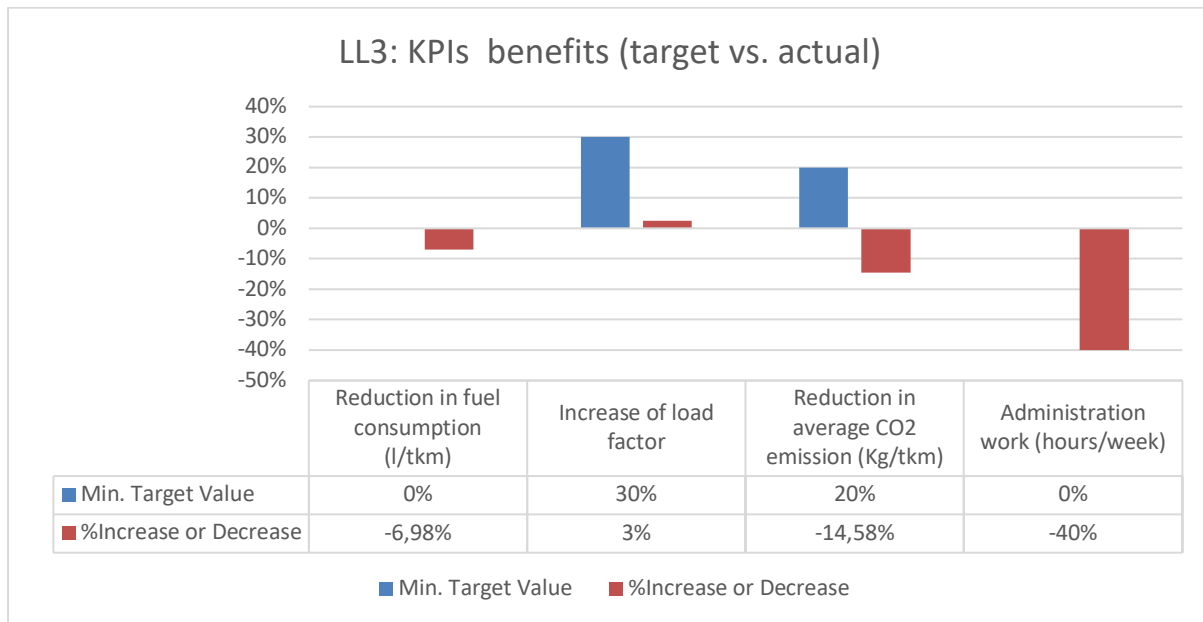


Figure 24: KPIs benefits at LL3 (target vs achieved or estimated)

Reduction in Fuel Consumption

Reduction in fuel consumption has been an important area to improve by many living labs. However, no target value has been set for LL3 related to reduction in fuel consumption at the beginning of AEOLIX project. LL3 was still able to measure the impact of AEOLIX in reduction of fuel consumption as shown in figure below. Before AEOLIX, the average fuel consumption for LL3 was 0.043 l/tkm. With the use of AEOLIX, LL3 was able to reduce the value to 0.04 gaining the almost 7% reduction in average fuel consumption. The increase in percentage of load factor resulted in more efficient transport of freight and decreased fuel consumption by 8% ($((0,040 - 0,043)/0,043) * 100\%$). One of the main reason for reduction in fuel consumption is the decrease number of LTL (less truck load) trips.

Theoretically, if consolidated trips increased then empty runs should be reduced, so total fuel consumption should be reduced as well. LL3 measured the fuel consumption of trucks before and after AEOLIX and the increase in the measured trucks is due to the heavier trucks (increase on load factor). LL3 estimated that it can save 1 trip for every 10 trips (this would end up in decrease on overall fuel consumption) from cargo consolidation but they couldn't measure that saving. LL3 calculated the fuel consumption using two different KPIs liters fuel/100 kms and liters fuel/ tonne.km (tkm). Although the first KPI is commonly used by carriers/transport operators because it is relatively easy to calculate, it is not particularly useful as a measurement of logistics energy efficiency or emissions intensity, except as an intermediate indicator. For example, it takes no account of how well loaded the vehicle is (in fact a poorly loaded vehicle will give a better figure), or whether it is efficiently-routed. The denominator tkm however can develop a true assessment of the logistics energy efficiency.

From LL3 the following data were collected before and after the implementation of Cargo Bundling Marketplace:

- Distance of shipment in kms. Specifically, the origin and the destination of the shipments were used to get the total amount of kms that were travelled for the delivery of the shipments.

- Type of truck that was used for the transport of the shipment. The trucks were differentiated based on their load capacity.
- Weight of the loaded shipment.
- Information on the consolidated shipments after the implementation of AEOLIX platform were provided.

Since LL3 did not have any data on the total amount of fuel consumed during these trips we used default factors to make the fuel consumption calculations as it can be found in (GLEC Framework 2.0, 2019¹). The default factors were calculated in the basis of fuel type, vehicle type (vehicle load capacity) and load factor. Default values are measured in terms of fuel consumption per tonne-kilometres. After calculating the fuel consumption, LL3 use fuel emission factors to convert the fuel and energy used to power freight transportation into Greenhouse Gas (GHG) emissions. LL3 apply the European emission factors for diesel fuel that account for emissions both during the production of fuel and its consumption at the point of use (Well-to-Wheel emissions). A summary for reduction in fuel consumption, before and after AEOLIX, is shown in Figure 25 below.

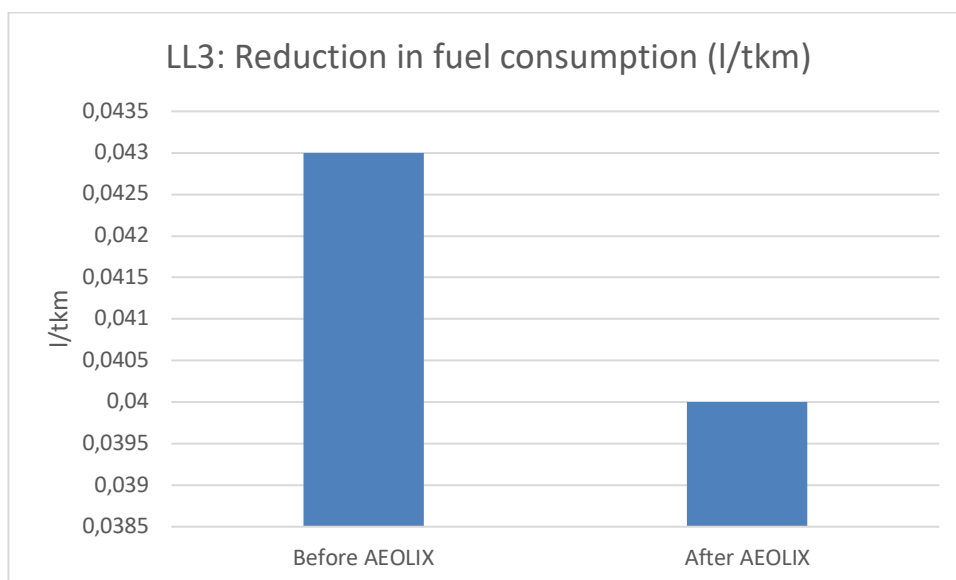


Figure 25: Reduction in fuel consumption at LL3 (before & after AEOLIX)

Increase in % of load factor

Increase in percentage of load factor help LL3 to assess how efficiently the truck is loaded. LL3 was able to achieve a small increase of 2,5% in the load factor after the implementation of Cargo Bundling Marketplace due to the low margin for improvement of the existing shipments mainly because almost all shipments were FTL (Full Truck Load).). The value for percentage of load factor before AEOLIX was 81% and after AEOLIX 83% as shown in Figure 26 below. AEOLIX helped LL3 to increase the load factor

¹ The Global Emissions Council Framework for Logistics Emissions Accounting and Reporting, Version 2.0, 2019. Smart Freight Centre. <https://www.smartfreightcentre.org/en/how-to-implement-items/what-is-glec-framework/58/>

due to order consolidation. It is more efficient than before in terms of demand allocation and time efficiency.

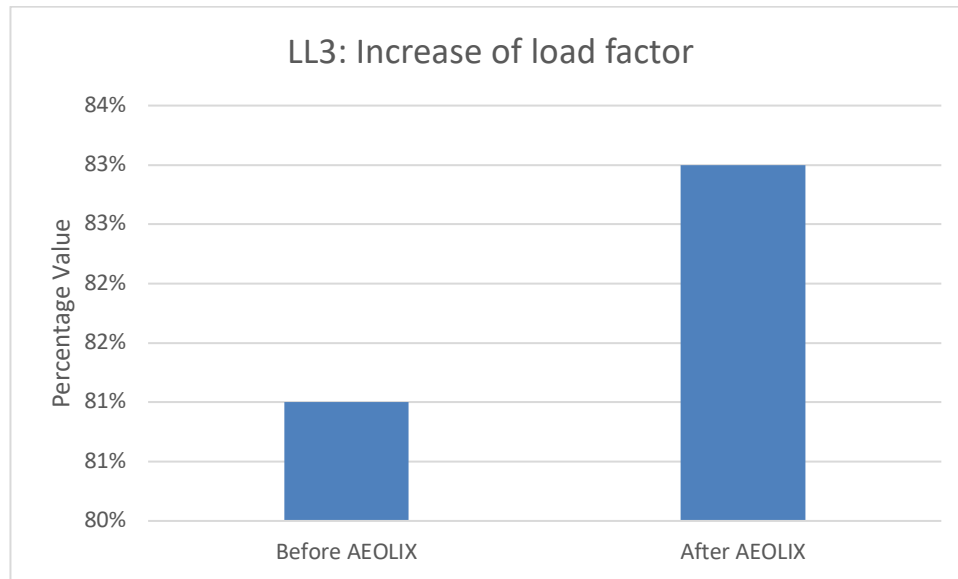


Figure 26: Increase of load factor at LL3 (before & after AEOLIX)

The increase in percentage of load factor is quite low for LL3. This is due to the fact that almost all of the trucking companies are already making consolidations (freight forwarding) in order to be competitive in today's highly competitive environment. So, most of the trucks are full trucks or almost FTL, thus having small margin of improvement. We succeeded to have a small increase due to cargo consolidation through the AEOLIX. Further increase could be succeeded for LL3.

Administration work

AEOLIX helped the participating companies in both LL3 services to reduce significantly the administration work time in order to perform their activities such as searching for available carrier/warehouse facility, find the better option among multiple options etc. Previously all these activities were performed manually through e-mails, telephones etc. but with the support of the AEOLIX now the companies can enter in the developed LL3 platforms (VFC & Cargo Bundling) and automatically publish their data and search for options and alternatives about their activities. With the help of AEOLIX, LL3 was able to save time on administration work from 20 hours per week to 12 hours per week. This results in 40% of time savings for activities related to administration work at LL3. The situation is shown in Figure 27 below.

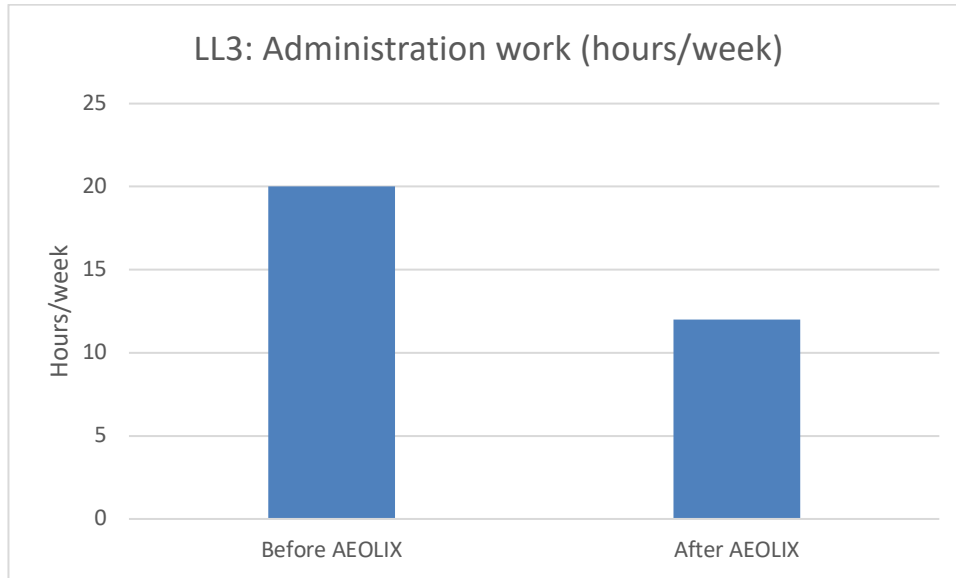


Figure 27: Administrative work benefit at LL3 (before & after AEOLIX)

Reduction for Waiting Time for Trucks in Terminal

Initially during the proposal phase, LL3 consortium had K+N (76uehne + Nagel) and its terminal in Thessaloniki. After the 1st contract amendment K+N left the project and replaced by TREDIT (developer of LL3) and OFAE (truck owners association), so there wasn't any terminal in LL3 in order to perform the experimental phase as described initially. So the KPI became not applicable.

Reduction of Average Loading/Unloading Time

Initially during the proposal phase, LL3 consortium had K+N (76uehne + Nagel) and its terminal in Thessaloniki. After the 1st contract amendment K+N left the project and replaced by TREDIT (developer of LL3) and OFAE (truck owners association), so there wasn't any terminal in LL3 in order to perform the experimental phase as described initially. So the KPI became not applicable.

Increase of Terminal Productivity

Initially during the proposal phase, LL3 consortium had K+N (76uehne + Nagel) and its terminal in Thessaloniki. After the 1st contract amendment K+N left the project and replaced by TREDIT (developer of LL3) and OFAE (truck owners association), so there wasn't any terminal in LL3 in order to perform the experimental phase as described initially. So the KPI became not applicable.

Decrease in % of Empty Runs

LL3 reduce the number of empty runs due to increase of cargo availability. The more users from truck companies and exporter they register the more positive results could be obtained. However, truck owners and exporters did not provide data on decrease in percentage of empty runs.

Level of service

Order fulfillment cycle time and deliver cycle time, level of service will increase. Lead time to customer order increase due to more shipments to be delivered to more consignees.

Visibility / Data Sharing

Visibility increased because now available supply and demand are visible through the platform. Before there wasn't any visibility on available demand.

Interoperability

Connectivity engine allows different systems to communicate in a simplified way and exchange information.

5.3.1. LL3 Business Aspects - *Reduced Operational Costs*

All the above mentioned benefits, in turn, provide financial benefits to LL3. Following Figure 28 shows the list of KPIs that impact on LL3 business by providing reduction in operational costs:

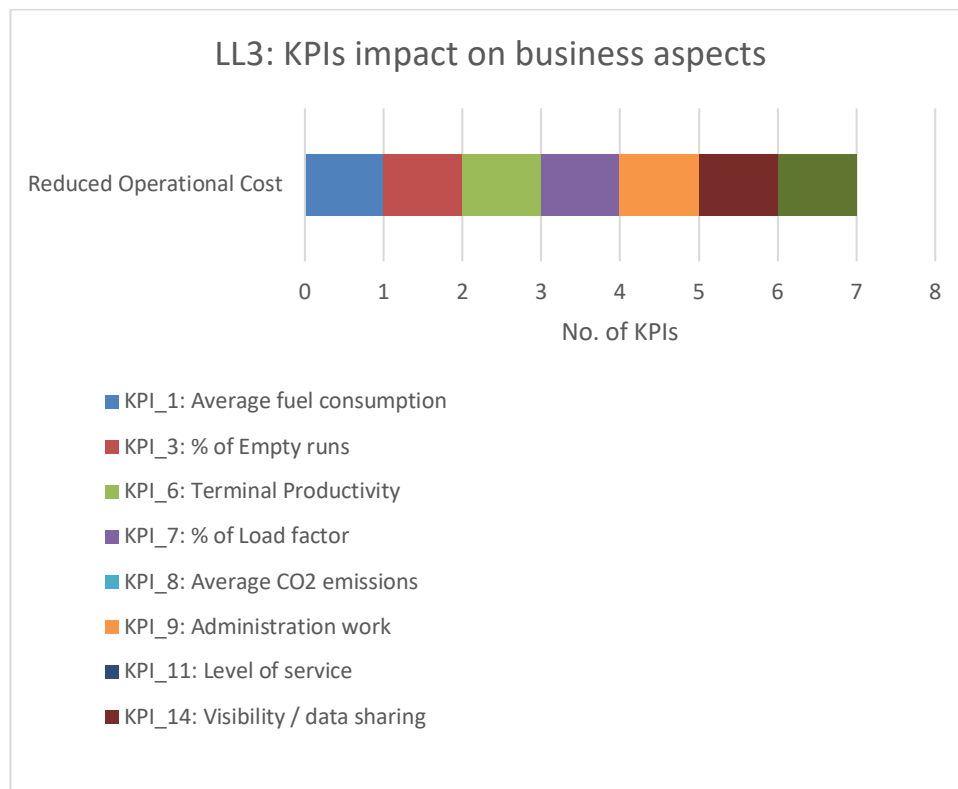


Figure 28: List of KPIs impacting on business at LL3

Due to the benefit obtained with the help of AEOLIX, LL3 was able to obtain number of financial benefits in terms of cost savings. A summary of these financial benefits is shown in Figure 29 below:

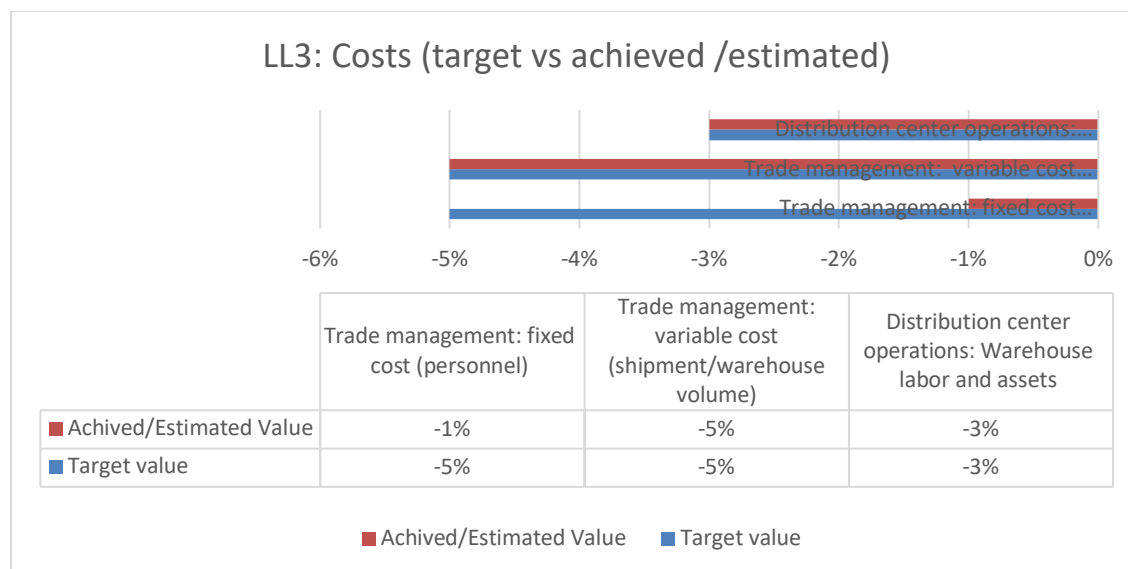


Figure 29: Summary of Cost savings at LL (target vs achieved)

Distribution Center Operations

LL3 was able to reduce costs related to distribution center operations through reduction in facilities labor. The target for distribution center operations was set to 3-5% for all living labs. This is clear from the figure above that LL3 was able to save cost by 3% meeting the minimum target value. The main costs were saved by reducing the warehouse labor and asset acquiring costs.

Trade Management

Trade management costs can be saved by reducing costs on activities related trade monitoring. LL3 was able to save two different costs related to trade monitoring including fixed cost for personal and variable cost for shipment and warehouse volume maintaining cost. For the fixed cost of personnel, LL3 was able to save only 1% against the target value of 5%+ related to trade management. However, LL3 was able to save variable cost related to shipment and warehouse volume by 5% hence achieving the minimum target value of 5%.

In addition to the above mentioned set costs types, one of the company within LL3 was able to save costs on two activities in term of time: search for available cargo (hr/truck) and search for available trucks for transport of the exporting shipments (hrs/shipment). Following figure shows the values before and after AEOLIX. The company was able to reduce time spent on search for available cargo from 20 hours/truck (before AEOLIX) to 12 hours/truck (after AEOLIX). Similarly, the company was able to save time from 17.5 hours/shipment to 13 hours/shipment with the use of AEOLIX. These benefits, in terms of time, are shown in figure below:

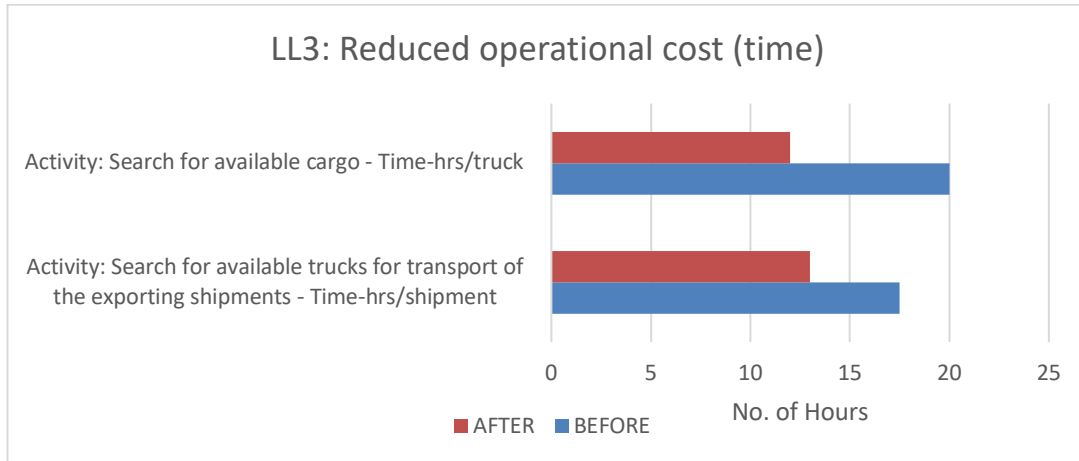


Figure 30: Time savings in various activities at LL3 (before & after AEOLIX)

5.3.2. LL3 Environmental Aspects

The environmental aspects consist of reduction in carbon footprints and noise pollution within LL3. Analysis of the results for each of the aspect is presented in the following sections, individually. There are number of KPIs impacting the environmental aspects as shown in Figure 31 below. These KPIs include the followings:

- Average fuel consumption
- Percentage of empty runs
- Terminal productivity
- Percentage of load factor
- Average CO2 emission
- Administration work

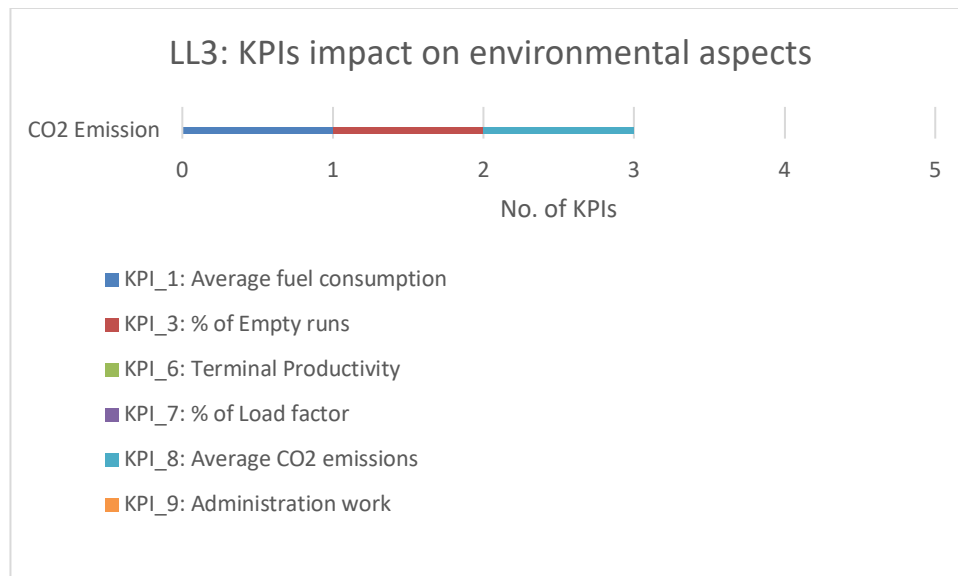


Figure 31: KPIs impacting environmental aspects at LL3

Reduced CO₂ Emissions

The use of AEOLIX has brought benefits for LL3 in terms of reduction in CO₂ emission. Following Figure 32 shows summary of results for CO₂ emission before and after AEOLIX for LL3. The value before AEOLIX was 0.144 and after AEOLIX is 0.14 CO₂ eq. l/tkm. This results in 14% reduction on CO₂ emission at LL3. Furthermore, average fuel consumption leads to reduced CO₂ emission. The CO₂ emissions usually increase due to increase in cargo weight- but on the other hand the overall trips were reduced.

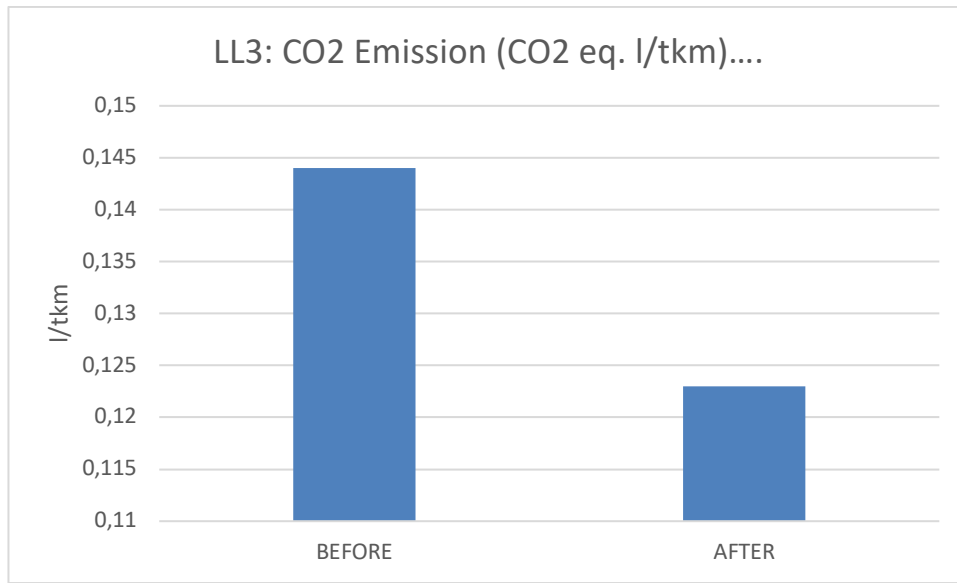


Figure 32: Reduced carbon footprints at LL3 (before & after AEOLIX)

However, this 14% reduction in CO₂ emission is taken as having a positive impact ‘but only to a little’ extent on the economy, average greenhouse gases reduction and environmental friendly logistics, in general. This little impact has been summarized in Figure 33.

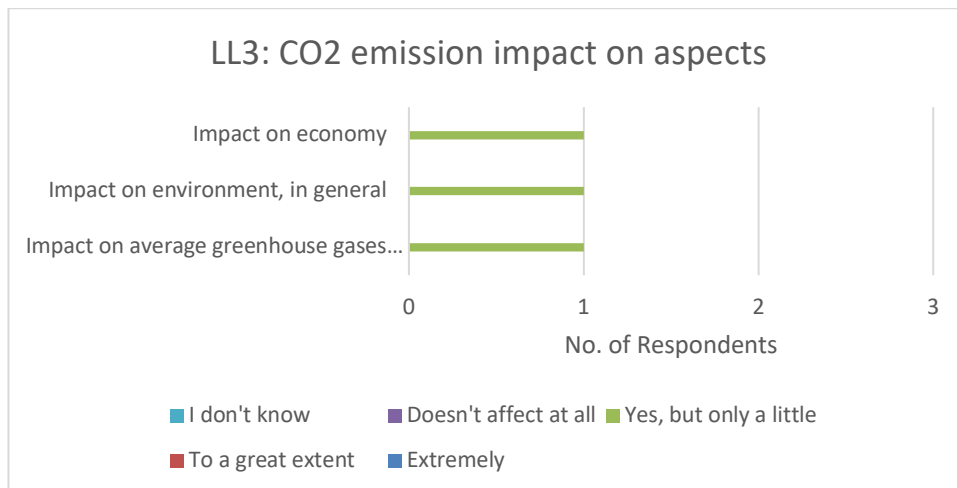


Figure 33: Impact of reduced carbon footprints on various aspects at LL3

Reduced Noise Pollution

AEOLIX has not been successful in reducing noise pollution at work for LL3 partners. Following Figure 34 shows the impact of AEOLIX on reducing noise pollution. It is clear that neither AEOLIX, in general, or various functions have helped LL3 partners in reducing noise pollution.

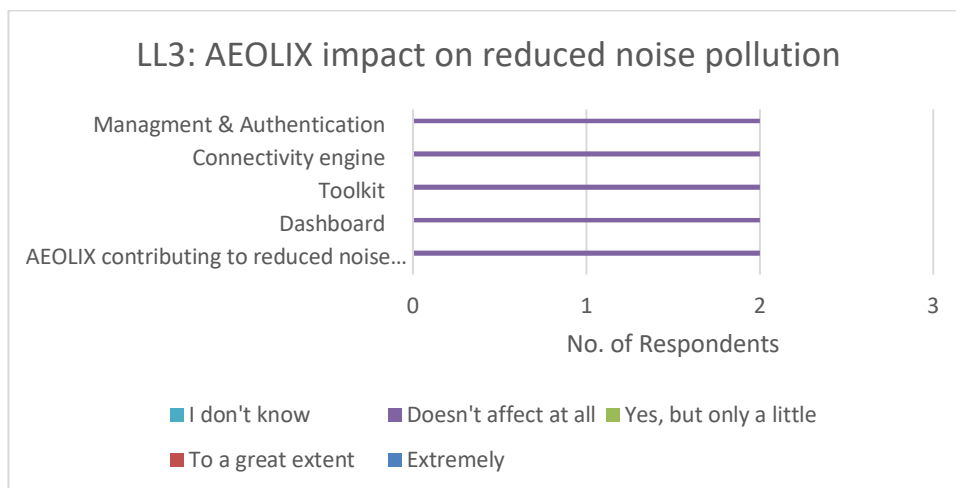


Figure 34: AEOLIX impact on reduced noise pollution at LL3

5.3.3. LL3 Socio-economic Aspects

Various socio-economic aspects are also impacted by number of KPIs as shown in Figure 35 below.

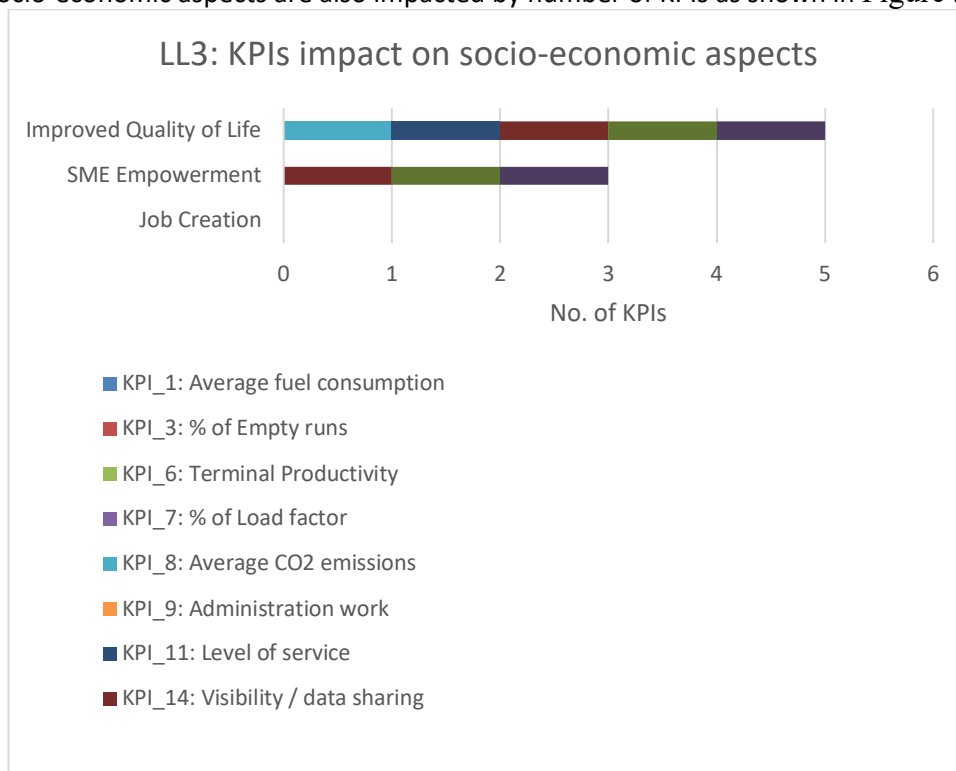


Figure 35: KPIs impact on socio-economic aspects at LL3

For example, CO2 emission, level of service, data sharing, interoperability and acceptance and trust contribute towards improved quality of life at LL3. Similarly, three KPIs data sharing, interoperability as well as acceptance and trust impact on SMEs improvement.

Job Creation

LL3 is unclear about the AEOLIX impact on job creation. Following Figure 36 shows the results for two managers who were asked about how many jobs will be created with the help of AEOLIX. But none of the respondents were sure about the benefits that AEOLIX can bring in terms of job creation.

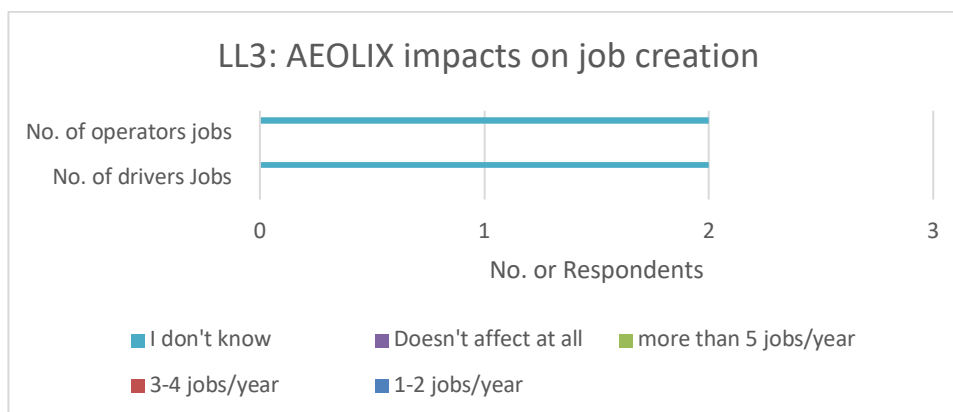


Figure 36: AEOLIX impact on job creation at LL3

SMEs Empowerment

The survey covered two aspects of SMEs empowerment for LL3: (i) To what extent AEOLIX is helpful in increasing market share for SMEs? And (ii) To what extent, AEOLIX helped SMEs to increased collaboration with large organizations? The results of respondents show that AEOLIX could be help in both cases, 'but only to a little' extent and are shown in Figure 37. The reason for AEOLIX low contribution include change in LL3 setting during the course of the project where some important stakeholder left the project.

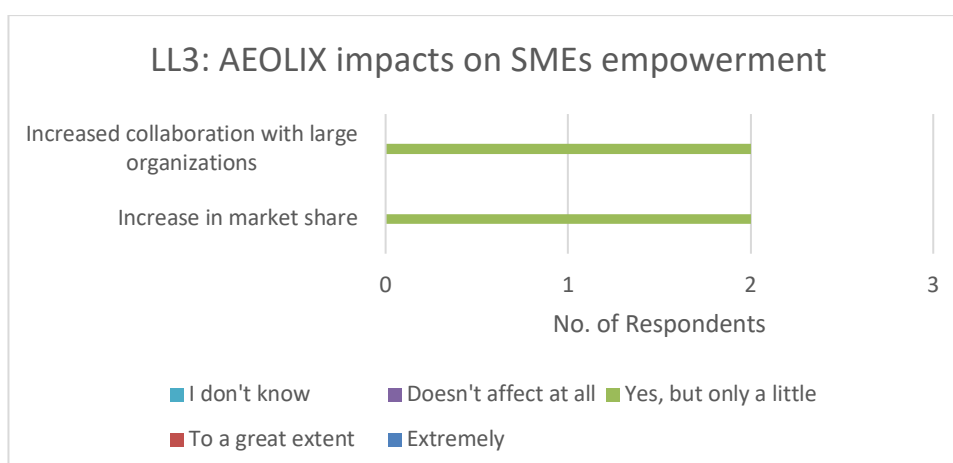


Figure 37: AEOLIX impact on SMEs empowerment at LL3

Quality of Life

The survey covered a number of aspects related to quality of life for employees at companies within LL3. Both managers noticed a small improvements where AEOLIX helped employees to put more focus on work and reduce stress at work by automating processes. Similarly, AEOLIX has not been beneficial to employees in providing reward such as less working hours or flexibility in working hours. Finally, LL3 has not experienced any improvement in people's attitude for those using AEOLIX. A summary of results is presented in Figure 38 below.

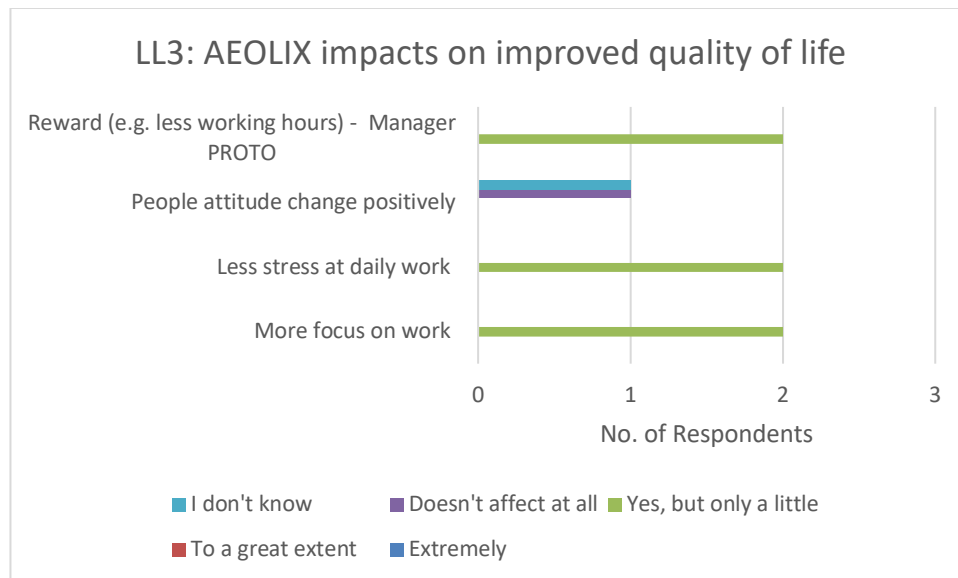


Figure 38: AEOLIX impact on improved quality of life at LL3

5.3.4. AEOLIX Acceptance and Trust at LL3

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures show how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis shows that LL3 evaluation manager thinks that AEOLIX use is directly related to the degree of approval to a greater extent for VFC. On the other side, AEOLIX helped only a little to improve the relationship with user for cargo bundling. Moreover, change in AEOLIX acceptance and trust level impact improved planning and overall performance, increased responsiveness, improved efficiency of operations, level of service quality and relationship with users 'to a great' extent. Some of the factors for that serve as barriers to AEOLIX acceptance and trust include the followings:

- At the moment, the new operations/procedure are not completely accepted.
- At the moment the users are using the platform, but they have suffered it as a forcing, so at the moment they see only slight advantages.
- Trust in the veracity of the found data, which means greater use and greater sharing of the platform.

A summary of these impacts are presented in Figure 39 below:

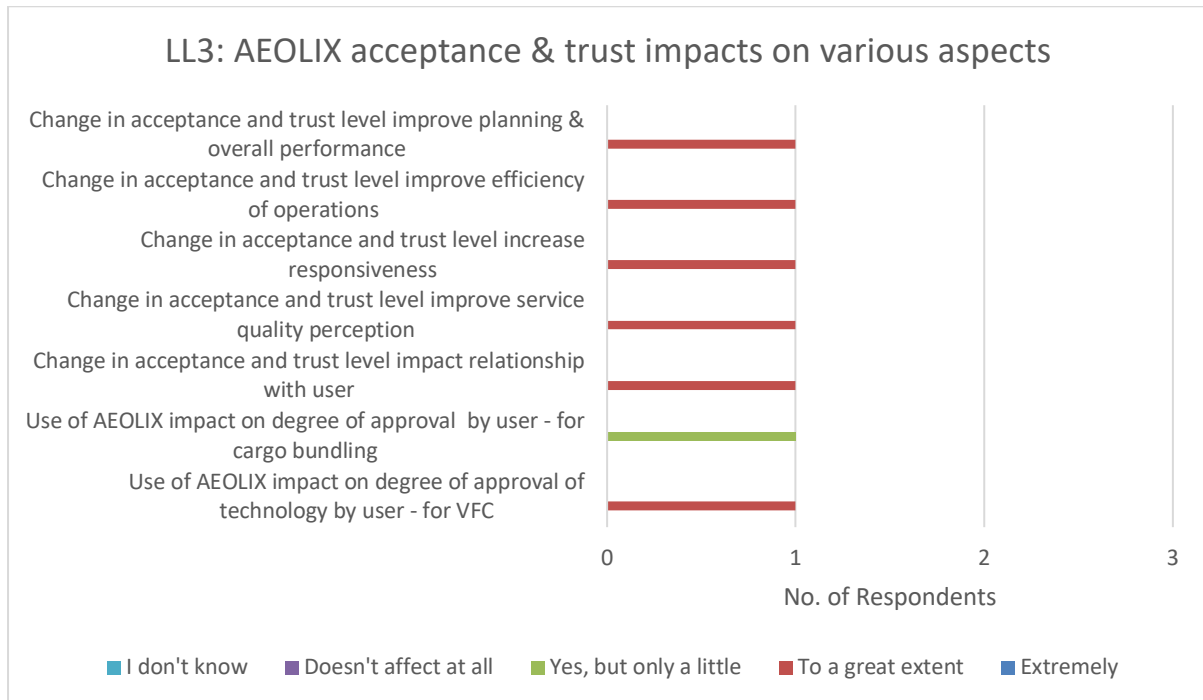


Figure 39: AEOLIX acceptance & trust impacts on various aspects at LL3

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 40 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL3 evaluation manager.

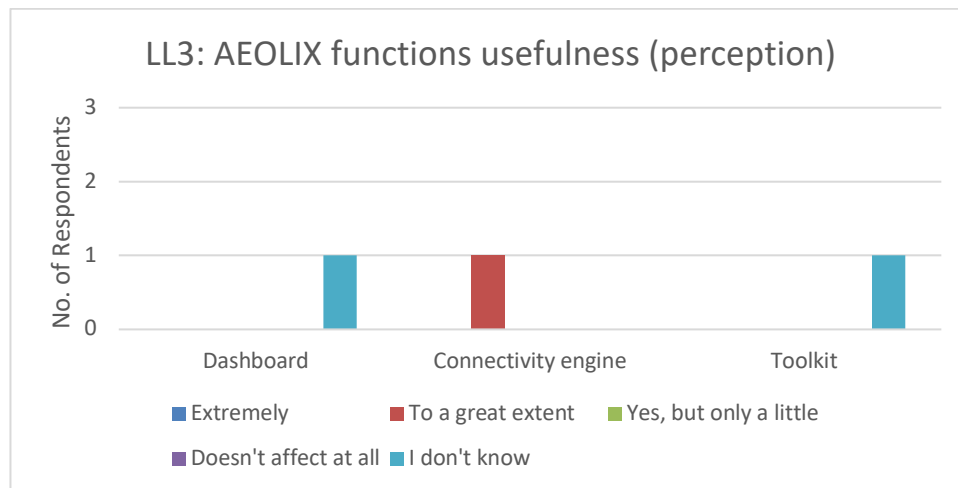


Figure 40: AEOLIX functions usefulness at LL3 (perception before AEOLIX)

The usefulness of two out of three functions, Dashboard and toolkit services, were not perceived fully by LL3 evaluation manager at the beginning of AEOLIX. While connectivity engines were perceived to be useful 'to a great extent' for LL3 users as a tool to connect them to other stakeholders.

However, after using AEOLIX, the usefulness of connectivity engine did not impact much to connect main LL3 stakeholders with other. Similarly, the usefulness for Dashboard and toolkit services were not proven beneficial for LL3 users. The results related to the actual usefulness of AEOLIX are shown in Figure 41 below:

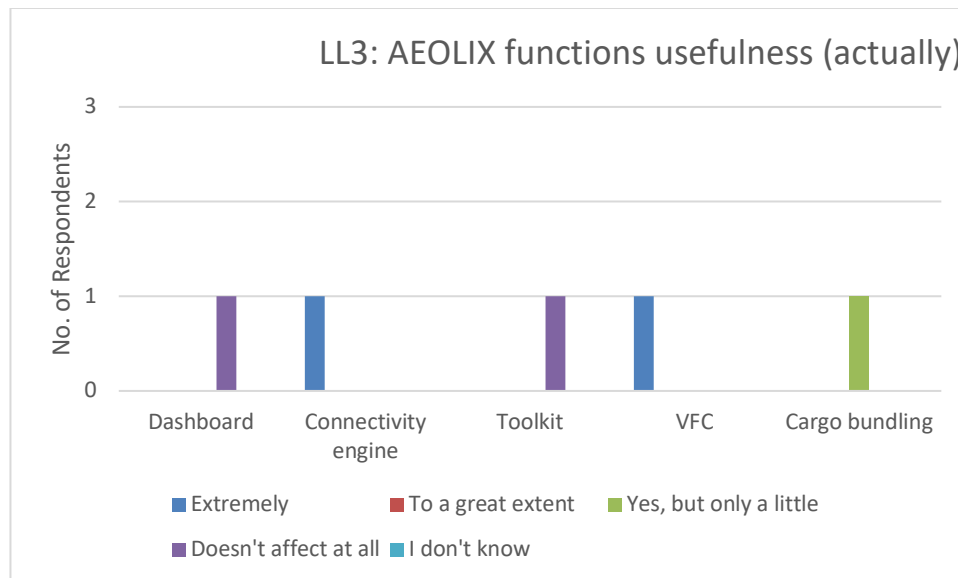


Figure 41: AEOLIX functions usefulness at LL3 (in actual after AEOLIX)

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users shows interest 'but to a little extent' only to continue using connectivity engine. While LL3 does not seems interested in using Dashboard and toolkit services of the AEOLIX platform. Only one extended function – VFC was met with a stronger intention in terms of continue using it. The willingness to continue using AEOLIX is directly related to the usefulness. Since the usefulness is not rated high, the willingness to continue using the system follows. The summary of respondents results on willingness to continue using AEOLIX is presented in Figure 42 below:

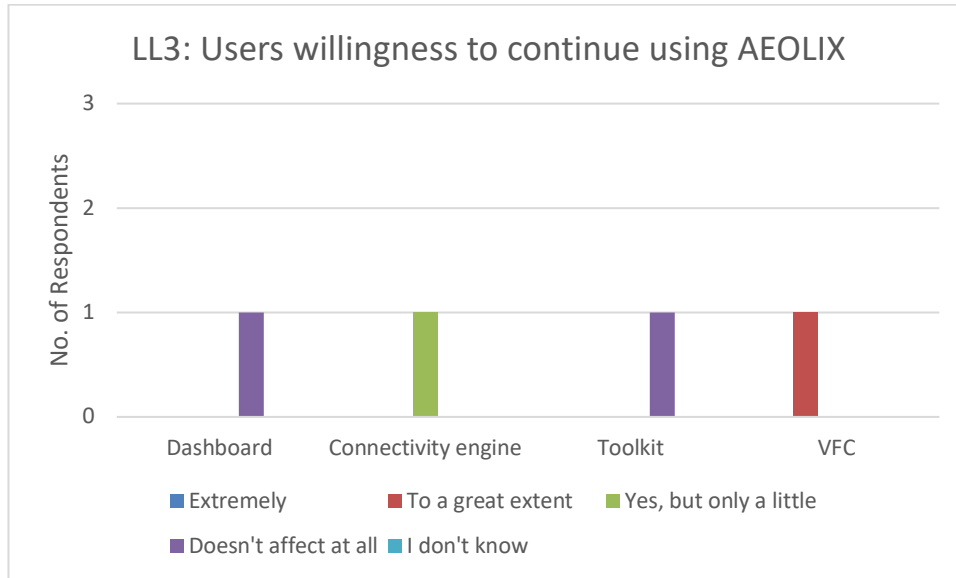


Figure 42: Users willingness to continue using AEOLIX at LL3

After willingness to continue using AEOLIX, this report asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results show that users trust, but only a little on cargo bundling. While the other two functions, connectivity engine and toolkit services failed to build users trust on them. Dashboard has not been used by LL3, therefore the evaluation manager is unaware of trust on this function. Only, and extended function of VFC, was able to win users trust within LL3 to a great extent. This is the result of average or even below average usefulness of AEOLIX as well as the errors and problems occur during the use of the system. A summary of users trust on various AEOLIX functions is presented in Figure 43 below:

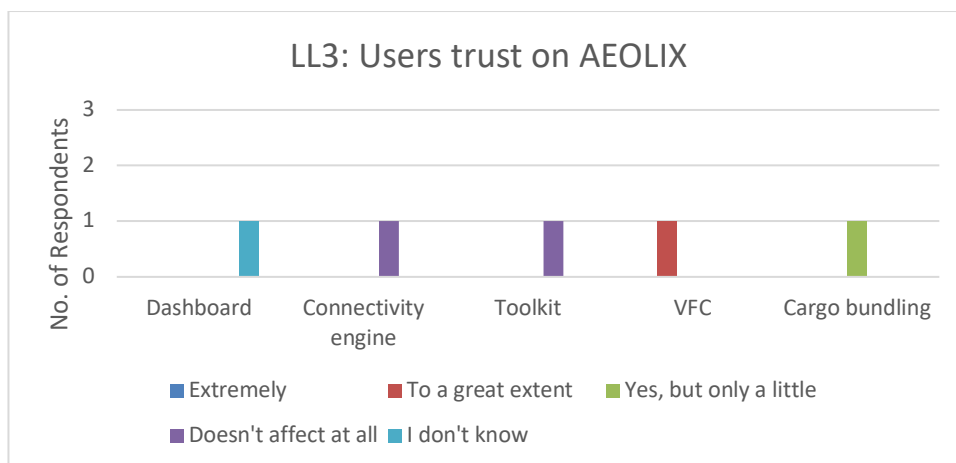


Figure 43: Users trust on AEOLIX at LL3

One of the reasons of low trust level may include little use of AEOLIX system which is less than 40 hours per month for LL3. The reason for little use is also associated with late development and implementation of the complete AEOLIX system. Again, LL3 does not use Dashboard and is not relevant in this case.

This study further investigated number of aspects related to AEOLIX acceptance at LL3. The results are presented in the Figure 44 below:

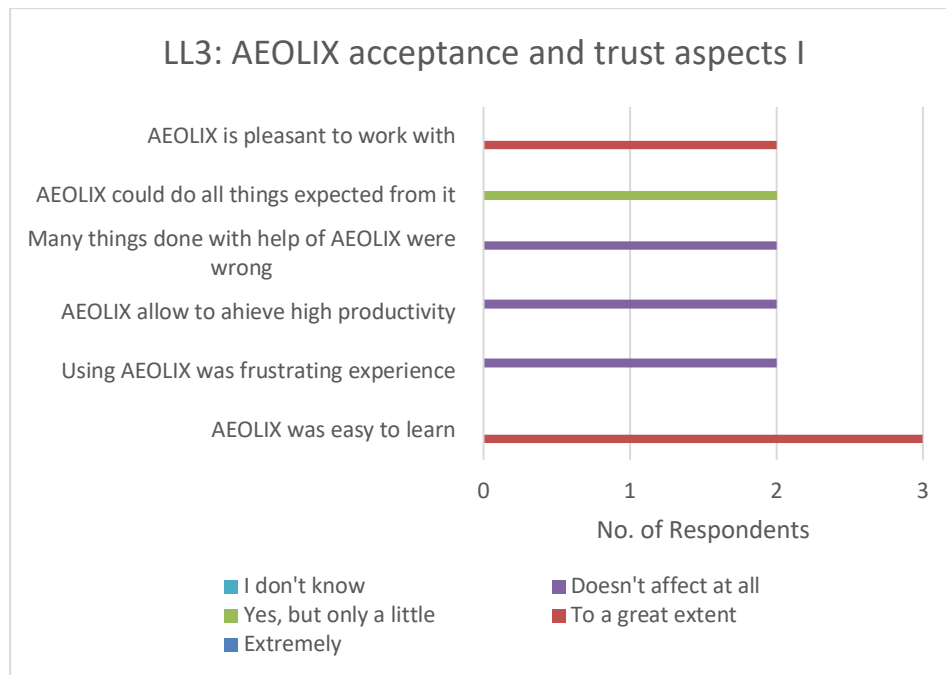


Figure 44: AEOLIX acceptance and trust aspects-I at LL3

The results depict that companies found it quite easy to learn the AEOLIX and various functions. Furthermore, the found it pleasant 'to a great extent' to work with AEOLIX within LL3. In terms of expectations, AEOLIX was only able to meet the performance expectancy to a little extent only. Luckily, LL3 users did not find AEOLIX as frustrating experience and most of the processes have benefited from AEOLIX. Finally, the AEOLIX benefits to increased productivity has not yet been fully experienced or anticipated at LL3.

Last but not the least, we probed into further aspects related to AEOLIX acceptance and trust as shown in Figure 45 below:

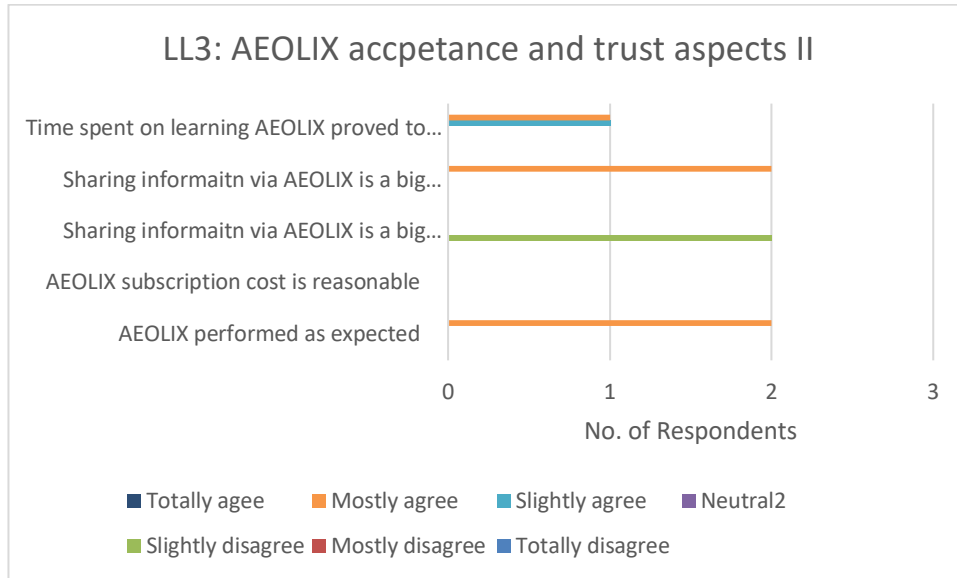


Figure 45: AEOLIX acceptance and trust aspects-II at LL3

The results depict that both managers 'mostly agree' with the fact that AEOLIX performed as expected. However, they also agree that sharing information via AEOLIX was proven to be a big hurdle in the adoption of the system. This is because some of the employees at both companies see sharing information as a serious concern among their employees. At large, managers agree that the time spent on learning and implement AEOLIX has been proved useful. Based on these aspects we can say that AEOLIX has medium to low acceptance and trust level.

5.4. LL4 Operational Impacts Assessment

Living lab 4 (LL4), also known as intermodal e-customs living lab, is situated in Trieste, Italy. Trieste is on the crossing of the **TEN-T Core Corridors Baltic-Adriatic** and Mediterranean, and on the **Adriatic-Ionian Motorway of the Sea**. LL4 is an example of intelligent hubs living labs. This LL has a main lead by the University of Trieste (UNITS) which is supported by AutoLogS, full partners, associated partners and third party companies or organizations. Full third companies involve Samer & Co. Shipping, Interporto di Trieste Inland Terminal, and Polytechnic of Bari (POLIBA).

The Trieste port is a free port for goods since 1719, with five free zones in which goods can stay without customs formalities and fees, and manipulation of goods is permitted (e.g. packaging, repackaging, labelling, sampling, eliminating brands, etc.) as well as their industrial transformation, completely free from any customs bond. Trieste is the terminus of regular direct ocean transportation services provided by the world's main shipping lines to China, the Far East, Singapore and Malaysia, with stops in several other ports in the Mediterranean Basin (Albania, Slovenia, Croatia, Greece, Turkey, Egypt, Lebanon, Israel, etc.).

Due to the urban location of the Trieste Port without sufficient possibility of development, the Interporto di Trieste Inland Terminal area has been realized outside the urban context. It consists of 30.000 m² of warehousing and 130.000 m² of open space for parking/customs bond/storage yards and it is directly connected to the motorway A4 Torino-Trieste, the motorway A23 Tarvisio-Trieste and the motorway Trieste-Ljubljana.

LL4 – **Intermodal e-Customs** addresses two main issues: (1) the improvement of the customs procedures and (2) the enhancement of the intermodal transport efficiency and quality.

Last but not the least, LL4 have some long term benefits with AEOLIX including

- 10% reduction of total transport time
- 10% reductions of CO2 emissions
- 4% reductions of the cost associated with intermodal transport
- Improved flexibility of intermodal transport

LL4 respondents are mainly managers with more than 6 years of experience in local companies. Therefore, we treat their responses as “experts opinions”.

LL4 deals with a number of different types of goods or products including:

- Textile and textile products; leather and leather products;
- Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media;
- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel;
- Other non-metallic mineral products;

- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks;
- Transport equipment;
- Furniture; other manufacturing goods n.e.c.
- Equipment and material utilized in the transport of goods;
- Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16;
- Other goods.

The local companies involved deal with various types of roadside trade traffics:

- Large freight containers;
- Other freight containers;
- Other mobile units;
- Palletized goods.

The local companies involved are currently doing their business within the Motorways of the Sea context, linking Continental Europe to Turkey and operated by RO-RO vessels (containers, trailers and semitrailers).).

The operational impacts assessment for LL4 has started with collecting data on the list of KPIs including:

- average fuel consumption
- average waiting time
- Terminal productivity
- Administration work
- Level of service
- Custom procedures
- Visibility / data sharing
- Financial benefits
- Acceptance and trust

Hereafter, a short description of services and how KPIs are related to services is provided:

Pre-Clearing Operations

Performing pre-clearing operation leads to logistic chain improvement based on the anticipation of dematerialized customs procedures. The following Table 11 shows the list of KPIs and how they related to pre-clearing operations:

Table 11: KPIs impacting pre-clearing operations at LL4

KPIs	Description of KPIs (i.e. how specific KPIs contributed to ETA updates)
KPI_1: Average fuel consumption	Average fuel consumption per trip/day/week/month/quarter etc. computed on the basis of the saved km.
KPI_4: Average waiting time	Time spent into Trieste inland terminal Ferneti (since when the trucks enter until they leave the intermodal hub)
KPI_6: Terminal productivity	a. Average trucks throughput (IMPORT); b. Average vessel throughput - service time (IMPORT); c. Average service time (IMPORT); d. Average workload for clearing; e. Average workload for clearing per work shift
KPI_9: Administration work	Time needed to execute customs processes (minutes)
KPI_13: Custom procedures	The administration work could be measured as sum of (times the new freight is ready to leave the port - times the new freight is ready for clearance operation)/number of freights cleared. This KPI can be calculated for freight using the preclearing option and freight using the typical approach

Secure and Paperless Data Sharing

Facilitating document transfer, booking, status across multiple logistics operators transporting freight from continental Europe to Turkey and return passing through the Trieste port. The following Table 12 shows list of KPIs and how they related to secure and paperless data sharing procedures via mobile application:

Table 12: KPIs impacting secure and paperless data sharing at LL4

KPIs	Description of KPIs (i.e. how specific KPIs contributed to ETA updates)
KPI_11: Level of service	Surveys about customer satisfaction for AEOLIX services
KPI_14: Visibility / data sharing	Terminal Visibility: <ul style="list-style-type: none"> • NS (Number of Subscribers) for each public channel; • TNS (Total Number of Subscribers) for all public channels; SD (Subscriber Distribution): the percentage of the number of subscribers' respect to the TNS for every country. Country SD= (Country TNS)/TNS

Trieste Area Data Sharing on relevant Events

Enhancement of the intermodal transport efficiency and quality, by facilitating document transfer, booking, status and incident and emergency management across multiple logistics operators transporting freight. Only one KPIs, acceptance and trust, was contributing to data sharing.

5.4.1. LL4 Business Aspects – Reduced Operational Costs

AEOLIX impact on business aspects results in reduced operational costs. Before going into specifics of reduced operational cost at LL4, this report presents the benefits gained with the use of AEOLIX. These benefits are presented in the form of KPIs. A summary is presented in the Table 13 below:

Table 13: Sumamry of KPIs at LL4 (before & after AEOLIX)

KPIs	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Reduction in fuel consumption (l/km)	n/a	6171	5037	-18.38%	A considerable reduction in fuel consumption due to use of AEOLIX
Reduction of waiting time for trucks in the terminal (hrs)	35-40%	8,5	8,17	-3.88%	The use of AEOLIX can help the already existing maritime procedures but there is still a marginal improvement.
Reduction of average loading/unloading time (hr)	10-12%	The use of AEOLIX does not affect loading/unloading procedure at LL4			
Increase of terminal productivity: trucks throughput (trucks/hrs)	15-40%	10	10.41	4.1%	number of trucks authorized to leave the port
Increase of terminal productivity: vessels throughput (vessels/hrs)		0.27610	0.27774	0.59%	number of vessels leaving the port for hour (or better for a day)
Increase of terminal productivity: Average service time (hrs)		46	45	2.17%	Sum of total staying time of vessels in port
Increase of terminal productivity: average workload for clearing(hrs/(vessels*operations))		0.079	0.078	1.27%	Sum of number of completed clearing operations per vessel / time of the operations)/number of vessels
Increase of terminal productivity: average workload for clearing per work shift (hrs) day		1020.5	1010.5	0.98%	Before AEOLIX: td= 1020.5h; tn=1055.833333336 h (2 workshift, day and night); td% = 0.492; tn%= 0.508; After AEOLIX: td= 1010.5h; tn=1045.833333336 h (2 workshift, day and night); td% = 0.554; tn%= 0.446
Increase of terminal productivity: average workload for clearing per work shift (hrs) night		1055.83	1045.83	0.95%	Before AEOLIX: tn=1055.833333336 h (2 workshift, day and night); td% = 0.492; tn%= 0.508; After AEOLIX: td= 1010.5h; tn=1045.833333336 h (2

					workshift, day and night); td% = 0.554; tn%= 0.446
Increase of % of load factor (CBM or weight)	30-35%	LL4 does not have information about the kind and amount of freight loaded on the truck			
Reduction in average CO2 emission		20348	17295	-15%	A considerable reduction in CO2 emission
Administration work (hrs/freight)		0,47773	0,41	-14%	A considerable reduction of time spent on administrative work.
Custom procedures (minutes)		480	460	-4.17%	Slight reduction in time spent on custom procedures.

Reduction in Fuel Consumption

According to AEOLIX DoW, LL4 has no target value for reduction in average fuel consumption. Still LL4 has considerable decrease in average fuel consumption of 18.38%. Average fuel consumption before AEOLIX was 6171 liters and after 5037 liters AEOLIX. This reduction in fuel consumption is due to reduction in distances traveled by trucks. This is shown in Figure 46 below:

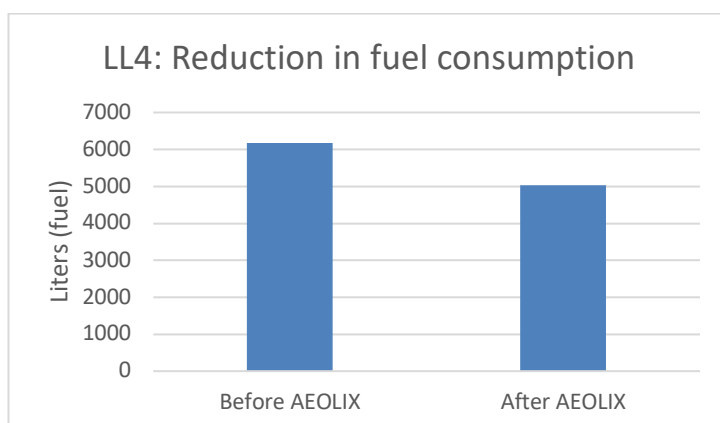


Figure 46: Reduction in fuel consumption at LL4 (before & after AEOLIX)

Reduction of Waiting Time for Trucks at Terminal

LL4 only has a marginal reduction in waiting time for trucks at terminal. The waiting time for trucks was 8.5 hours before AEOLIX and 8.17 hours after AEOLIX. This results in only 3.88% of reduction in waiting time for trucks at terminal. Therefore, there is only a marginal improvement of about 4% against an ambitious target of 35-40% for intelligent hubs types of living labs. The difference in reduction of waiting time for trucks at terminal is shown in Figure 47 below:

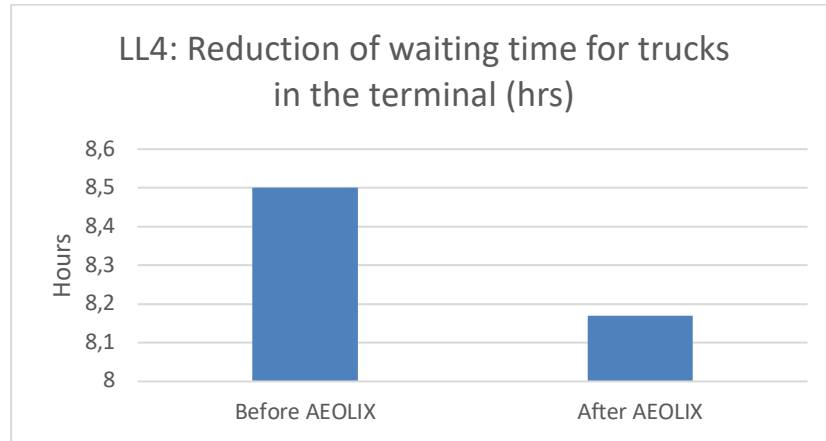


Figure 47: Reduction of waiting time at LL4 (before & after AEOLIX)

Increase of Terminal Productivity

Increase of terminal productivity at LL4 is a complex process and a combination of number of factors including average trucks throughput, average vessel throughput, average service time, average workload for clearing, and average workload for clearing per work shift (day and night).

The increase of terminal productivity is measure as follows:

- *Average trucks throughput (IMPORT)*: number of trucks authorized to leave the port for hour. Before AEOLIX: 10 trucks/h; After AEOLIX: 10,41 trucks/h accounting to 4.10% increase;
- *Average vessel throughput - service time (IMPORT)*: number of vessels living the port for hour (or better for day). Before AEOLIX: 0.276 10 vessels/h; After AEOLIX: 0.2774 vessels/h accounting to 0,59% increase;
- *Average service time (IMPORT)*: sum of the total staying time of vessels in port. Before AEOLIX: 46 h; After AEOLIX: 45h accounting to saving of 2.17% on time;
- *Average workload for clearing*: sum of (number of completed clearing operations per vessel /time of the operations)/number of vessels. Before AEOLIX: 0,079 h/(vessels*operations); After AEOLIX: 0.078 h/(vessels*operations) accounting to 1.27%-time savings;
- *Average workload for clearing per workshift*. Before AEOLIX: $t_d = 1020.5h$; $t_n = 1055.833333336h$ (2 workshift, day and night); $t_d\% = 0.492$; $t_n\% = 0.508$; After AEOLIX: $t_d = 1010.5h$; $t_n = 1045.833333336h$ (2 workshift, day and night); $t_d\% = 0.554$; $t_n\% = 0.446$ accounting to 0.98% time savings for day shift and 0.95% time savings for night shifts;

Following Figure 48 shows the increase of terminal productivity:

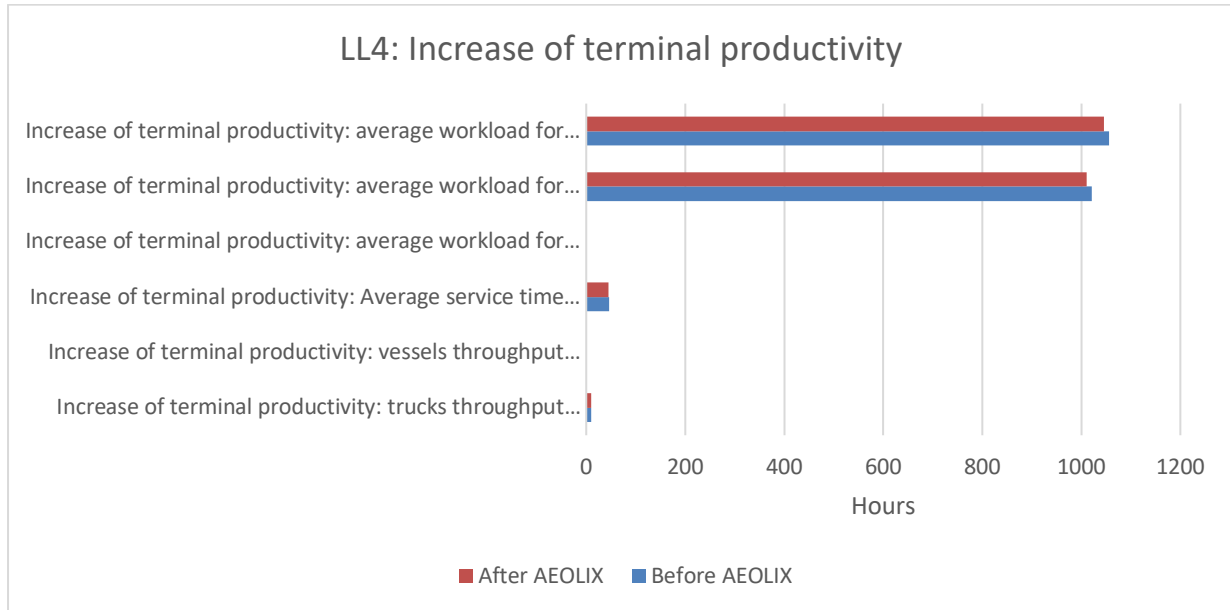


Figure 48: Increase of terminal productivity at LL4 (before & after AEOLIX)

The called system (export) and pre-clearing (import) distribute the bureaucratic operations in a larger time interval. For the transport companies, this means that the drivers can rest at the inland terminal and they can saving time in queue at the port entrance. Moreover, the online information about the clearing status can help them to improve the estimation time of delivery in real time.

Administration Work

Another area where AEOLIX has been useful to some extent is related to administration work for freights at LL4. The living lab was spending 0.477773 hours per freight before AEOLIX. With the use of AEOLIX, this value has reduced to 0.41. This means that LL4 is saving 14% of time which it used to spent on administrative procedure for each freight. The difference in reduction is shown in the Figure 49 below:

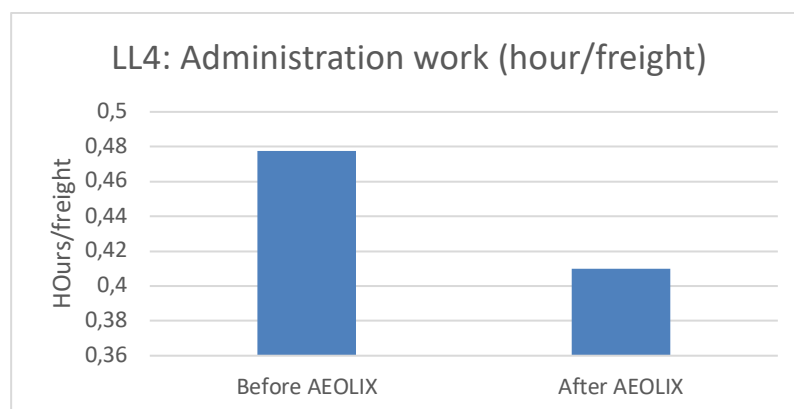


Figure 49: Administrative work benefits at LL4 (before & after AEOLIX)

Custom Procedures

In addition to the aforementioned areas, LL4 also benefited from the use of AEOLIX for custom procedures. The bureaucratic customs procedures were consuming 48 minutes before AEOLIX and 46 minutes after AEOLIX with 4% reduction in time spent on custom procedures. One of the potential reason for this low percentage is that customs procedures still involve human and traditional bureaucratic processes. This is shown in Figure 50 below:

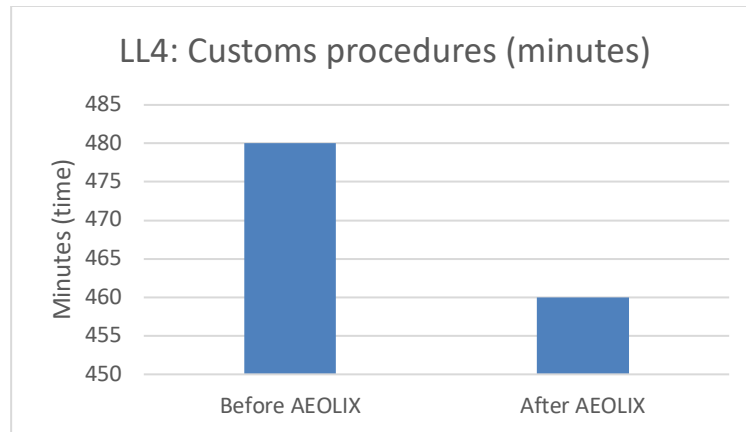


Figure 50: Customs procedures benefits at LL4 (before & after AEOLIX)

Reduction of Average loading/Unloading Time

The target for reduction of average loading or unloading time was set to 10-12% for intelligent hub types of living lab (LL4 is part or example of this intelligent hub type of living labs). However, the use of AEOLIX has not affected loading or unloading time at LL4.

Increase of Load Factor

The target for increase of load factor was set to 30-35% for intelligent hub types of living lab (LL4 is part or example of this intelligent hub type of living labs). However, LL4 do not have the information about the kind and amount of freight loaded on the truck. This information is necessary to measure the load factor before and after AEOLIX. Therefore, in the absence of this information the increase of load factor cannot be measured at LL4.

Level of Service

AEOLIX has been very useful in neutralizing the perception about level of services at LL4. Before the use of AEOLIX, 30% customers rate the level of services as bad and 40% as neutral. After the use of AEOLIX, the percentage with negative perception has reduced to 13% as neutral and 50% as neutral. There has been a slight increase from 30% to 36% in the positive perception about level of service at LL4. The result shows are shown in Figure 51 below:

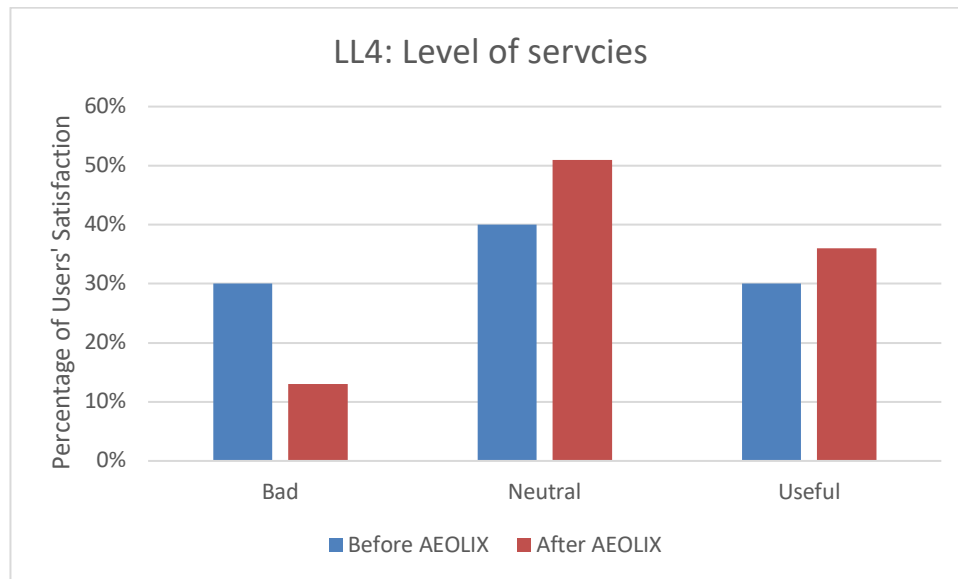


Figure 51: Level of service at LL4 (before & after AEOLIX)

Visibility / Data Sharing

Visibility and data sharing are helping LL4 to increase trustiness of their users by increasing the transparency of the logistic activities. Furthermore, if the transport operators can access to the clearance status in the real time, they will be able to organize a better schedule for their own tasks.

Translating all of the aforementioned areas of advantages, AEOLIX brings a number of financial benefits for LL4. A summary of these benefits is provided in the Table 14 below:

Table 14: Summary of financial benefits at LL4 (before & after AEOLIX)

LL4	Target value	Before AEOLIX	After AEOLIX	Achived/Estimated Value	Activities (Reasons)
C1. Logistics management (through trade management) - target 5.5-6%					
	5%	€ 57 000	€ 54 755	-4%	Truck (related to the cost of the drivers)
C2. Logistics management (through trade management) - target 5.5-6%					
	5,00%	93975	77160	17%	Workload Factor (reallocation of worked hours)
C4. Distribution center operations (through reduction in facilities and labor) - target 3-5%					
	5%	€ 1 832 669	€ 1 831 510	≤1%	Vessel (Pre-clearing improves the service time per vessel)

The following Figure 51 shows the summary of these cost savings in percentage, before and after AEOLIX:

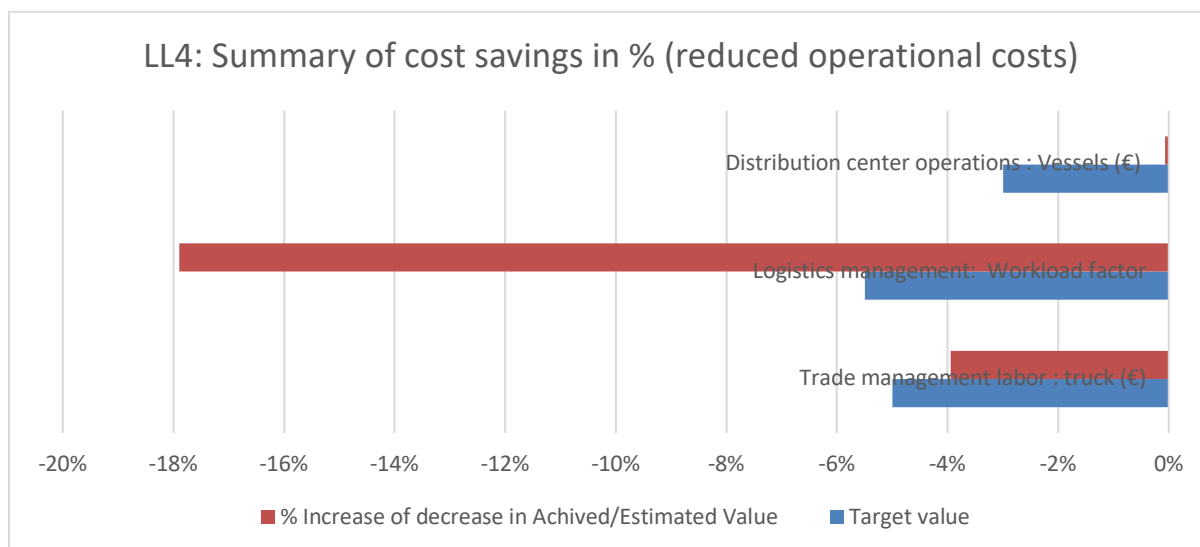


Table 15: Summary of cost savings at LL4 (target vs achieved value)

Trade Management Labor (through Trade Monitoring) - Target 5%

LL4 has saved a considerable amount of money related to trade management. The cost is specifically related to the cost of drivers' operations. Before AEOLIX, drivers costed 57000 euros and after AEOLIX, the cost estimation or achievement is 54755 euros. This result in almost 4% cost savings.

Logistics Management (through Trade Management) – Target 5.5-6%

LL4 has saved a great deal of money by reducing costs related to logistics management. The cost is specifically related to the relocation of working hours. Before AEOLIX, drivers costed 93975 euros and after AEOLIX, the cost estimation or achieved amount is 7716 euros. This leads to almost 18% in cost savings on logistics management. This financial benefit is way above the targeted value of 5.5-6% for costs related to logistics management.

Distribution Center Operations (through reduction in Facilities and Labor) – Target 1-3%

LL4 has saved very little amount of money by reducing costs related to distribution. The cost is specifically related to pre-clearing which ultimately improves the service time spent on each vessel. Before AEOLIX, drivers costed 1832669 euros and after AEOLIX, the cost estimation or achieved amount is 183150 euros. This leads to almost less than 1% in cost savings on activities related to distribution center operations.

5.4.2. LL4 Environmental Aspects

Reduction in Average CO₂ Emission

Like fuel consumption, LL4 also gain considerable amount of reduction in CO₂ emission. Before AEOLIX, CO₂ emission for LL4 had the value of 20348 kg which has reduced to 17295 kg after AEOLIX. This accounts for 15% in reduction for average CO₂ emission for LL4. One of main reasons for reduction in

CO₂ emission is reduction of fuel consumption. Following Figure 52 shows the difference in the reduction of CO₂ emission:

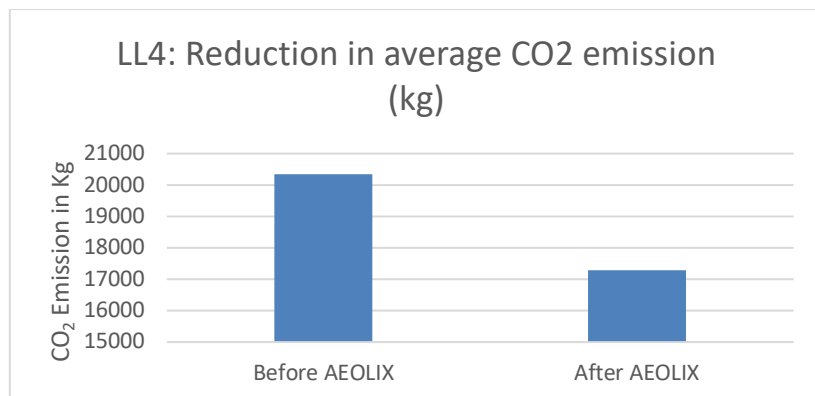


Figure 52: Reduction in carbon footprints at LL4 (before & after AEOLIX)

Reduced Noise Pollution

AEOLIX, in general, and management and authentication function in particular are considered to contribution reduction of noise pollution both for management and drivers. However, AEOLIX can only help to reduce the noise 'to a little extent'. On the other hand, respondents do not know about if or how other three functions (dashboard, toolkit and connectivity engine) has helped to reduce noise pollution at their workplaces. An overview is presented in Figure 53 below.

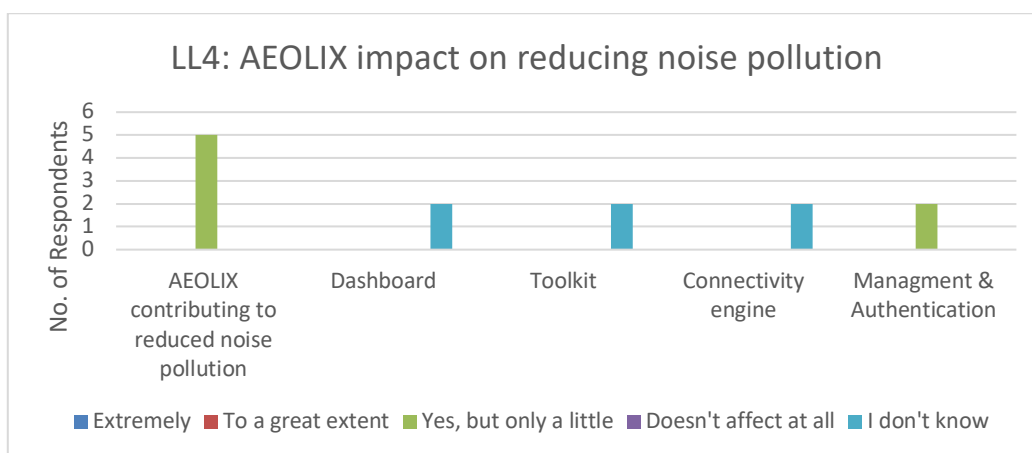


Figure 53: AEOLIX impact on reduced noise pollution at LL4

5.4.3. LL4 Socio-economic Aspects

Socio-economic aspects include job creation, SMEs empowerment and improved quality of life. A description of results on aspects related to socio-economic impacts is presented in the following paragraphs.

Job Creation

This seems that respondents at LL4 were unable to see or foresee the impact of AEOLIX on job creation. A potential reason may include the short time period during which LL4 was able to make an impact on daily business activities. A summary is presented in Figure 54 below.

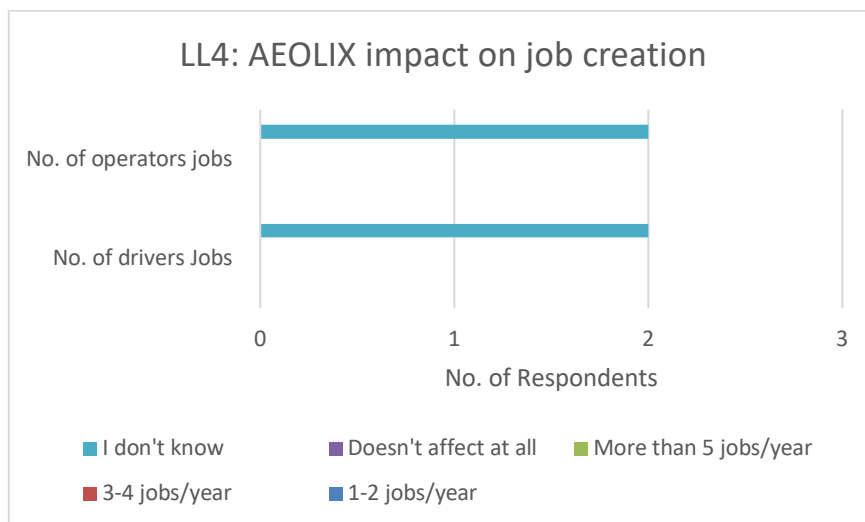


Figure 54: AEOLIX impact on job creation at LL4

SMEs Empowerment

This study reports two aspects related to SMEs empowerment as shown in the Figure 55 below. For increase in market share for SMEs, the respondents think AEOLIX has or will have 'only a little impact'. However, the respondents are more optimistic and think that AEOLIX will be useful 'to a great extent' for SMEs in making partnerships with large organizations.

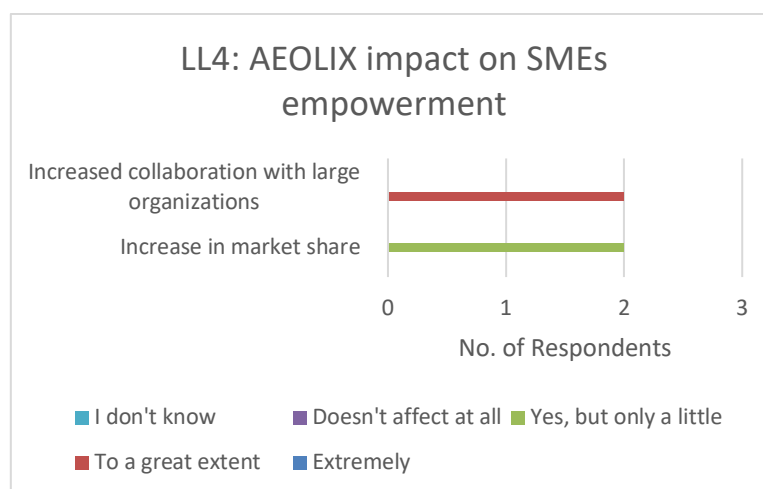


Figure 55: AEOLIX impact on SMEs empowerment at LL4

Improved Quality of Life

Last but not the least, AEOLIX has varied impacts on different aspects of improved quality of life for employees working in companies within LL4. The perception on these aspects have been collected from managers and drivers at LL4. A summary of responses is presented in Figure 56 below:

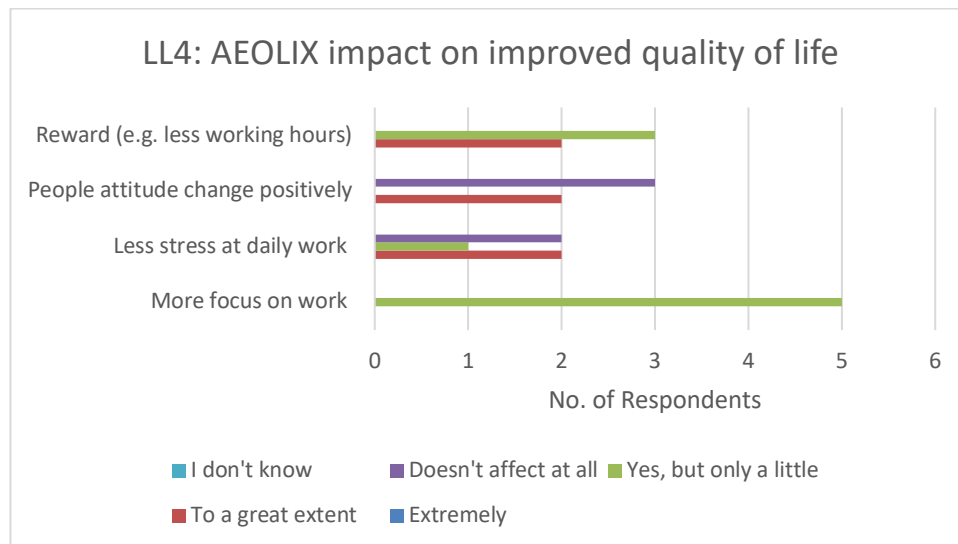


Figure 56: AEOLIX impact on improved quality of life at LL4

The results show that all of the respondents share the common view that AEOLIX has helped 'but only a little' to put more focus on their daily work. However, the respondents expressed different view when it comes to use of AEOLIX leading to less stress at daily work. Two respondents expressed that AEOLIX has helped them 'to a great extent' in reducing or experiencing stress at daily work. While one of the respondents think that AEOLIX has helped 'but only to a little extent'. However, two of the respondents think that the use of AEOLIX has 'no effect' on reducing stress at their daily work. Similarly, respondents have two distinct categories with the use of AEOLIX leading to recognition or positive attitude from co-workers. One group with two respondents, think that the use of AEOLIX has helped 'to a great extent' to get themselves recognized at the workplace. However, the rest of three does not see any difference in people attitude even after using AEOLIX. Last but not the least, the use of AEOLIX shows gradual results. This means that two respondents think that AEOLIX has rewarded (e.g. less working hours) them 'to a great extent'. However, the rest of the three thinks that the use of AEOLIX has rewarded them 'but only a little'.

5.4.4. LL4 – AEOLIX Acceptance and Trust at LL4

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis show that LL4 evaluation manager thinks that AEOLIX use is directly related to the degree of approval. However, change in AEOLIX

acceptance and trust level impact improved planning and overall performance, increased responsiveness, improved efficiency of operations, and relationship with users 'but only to a little extent. Some of the factors for this little impact include the followings:

- At the moment, the new operations/procedure are not completely accepted.
- At the moment the users are using the platform without being mentally prepared, so at the moment they see only slight advantages.
- Trust in the veracity of the found data, which means greater use and greater sharing of the platform.

A summary of these impacts are presented in the Figure 57 below:

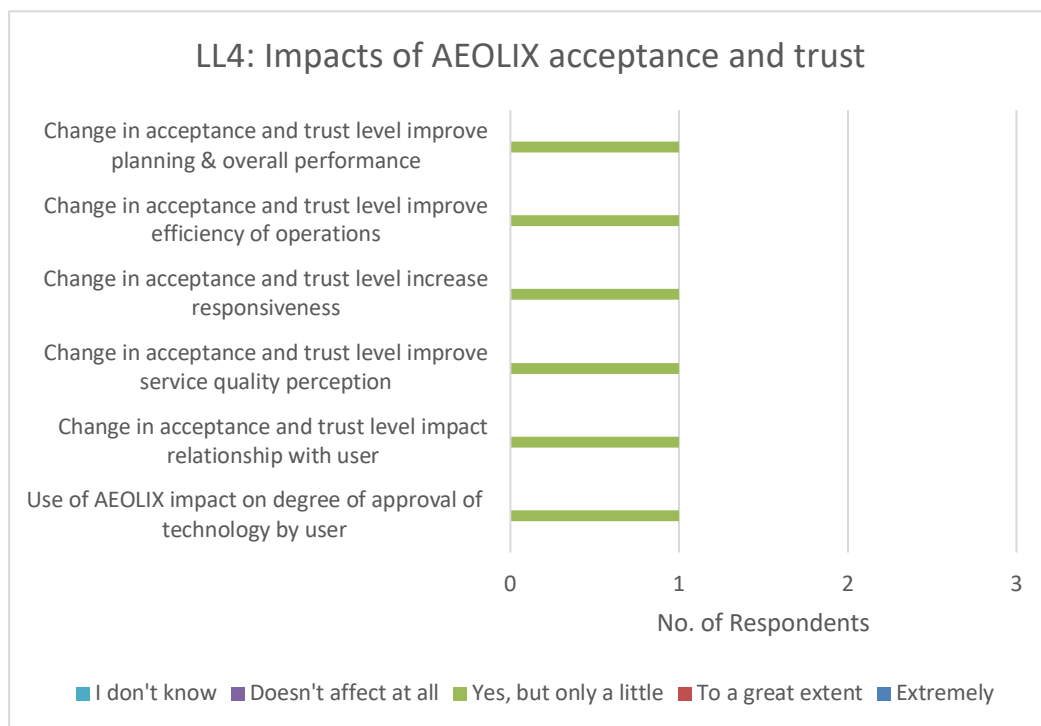


Figure 57: AEOLIX acceptance and trust impacts on various aspects at LL4

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 58 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL4 evaluation manager. All three functions of AEOLIX are thought to be useful 'but to a little extent only. This implies that respondents were not optimistic about the various functions as the project development moved on and they know that this was a research project.

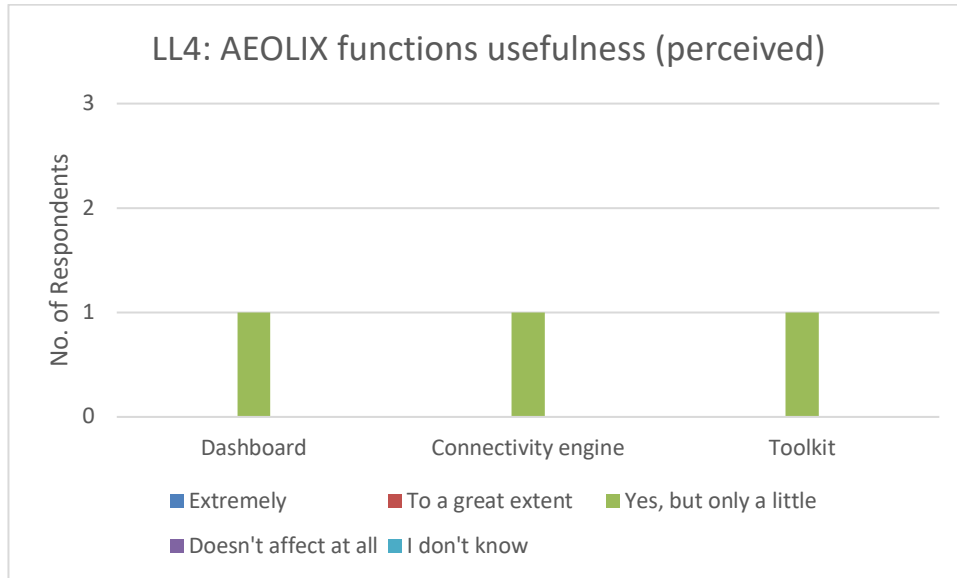


Figure 58: AEOLIX functions usefulness at LL4 (Perception)

However, after using AEOLIX connectivity engine proved to be most useful 'to a great extent'. This means that LL4 was satisfied as soon as they could connect with the other stakeholder. On the other hand, Dashboard proved to be useful 'to a little extent' as perceived. Last but not the least, toolkit services are does not seems to meet the expectation of LL4 evaluation manager. The results imply that the acceptance and trust on AEOLIX is moderate, since the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system. An overview of results is presented in Figure 59.

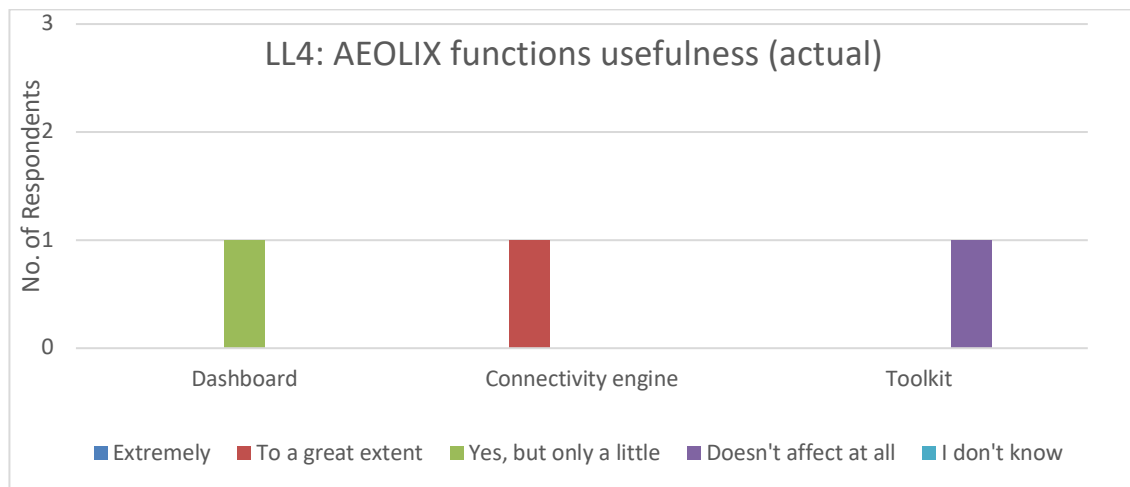


Figure 59: AEOLIX functions usefulness at LL4 (in actual)

This study further probed into the what was actually expected of AEOLIX and what users got. For LL4, AEOLIX was perceived as a system for providing faster paperless procedures and better reallocation of workloads. Managers at companies are satisfied with the AEOLIX in meeting their expectations.

The study continued to ask question about users' willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows a users' interest 'but to a little extent' only to continue using Dashboard and connectivity engine. While LL4 does not seems interested in using toolkit services of the AEOLIX platform. The willingness to continue using AEOLIX is directly related to the usefulness. Since the usefulness is not rated high, the willingness to continue using the system follows. The summary of respondents results on willingness to continue using AEOLIX is presented in Figure 60 below:

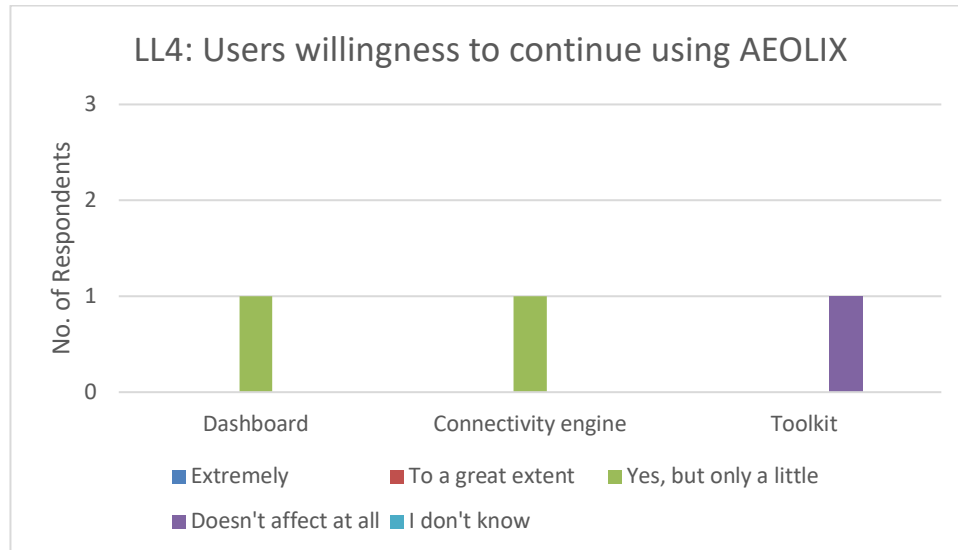


Figure 60: Users willingness to continue using AEOLIX at LL4

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results show that users trust, but only a little on dashboard and connectivity engines. This is the result of average or even below average usefulness of AEOLIX as well as the errors and problems occur during the use of the system. A summary of users trust on various AEOLIX functions is presented in Figure 61 below:

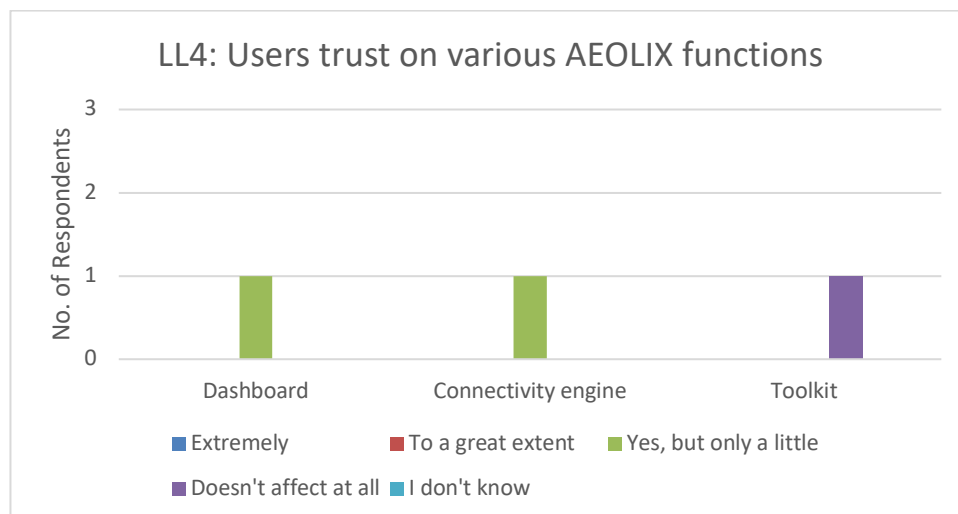


Figure 61: Users trust on AEOLIX functions at LL4

One of the reasons of low trust level is little use of AEOLIX system which is less than 40 hours per month for LL5. The reason for little use is also associated with late development and implementation of the complete AEOLIX system. Again, LL4 does not use toolkit services and is not relevant in this case.

This study further investigated number of aspects related to AEOLIX acceptance. The results are presented in the Figure 62 below:

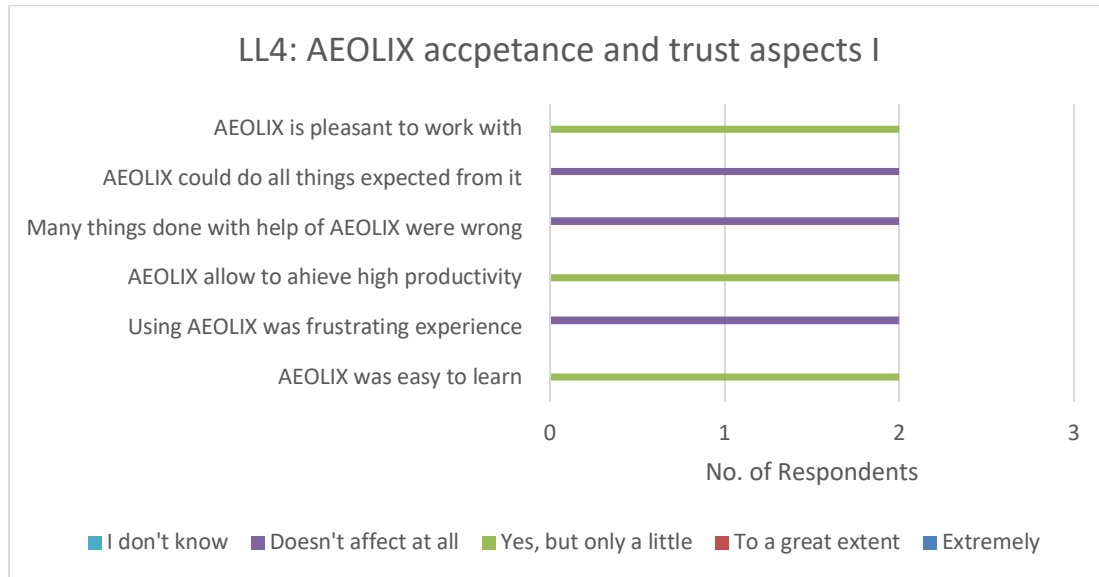


Figure 62: AEOLIX acceptance and trust aspects-I at LL4

The results depict that that two respondents agree 'but only to a little extent' that AEOLIX was pleasant to work with or that it was easy to learn the system or that it helped to achieve high productivity. Finally, LL4 managers think that AEOLIX meeting expectations from it; frustration while using AEOLIX; or things done with AEOLIX and proven wrong are not applicable to the acceptance and trust on AEOLIX. Based on these aspects we can say that AEOLIX has medium to low acceptance and trust level.

Last but not the least, we probed into further aspects related to AEOLIX acceptance and trust as shown in the Figure 63 below:

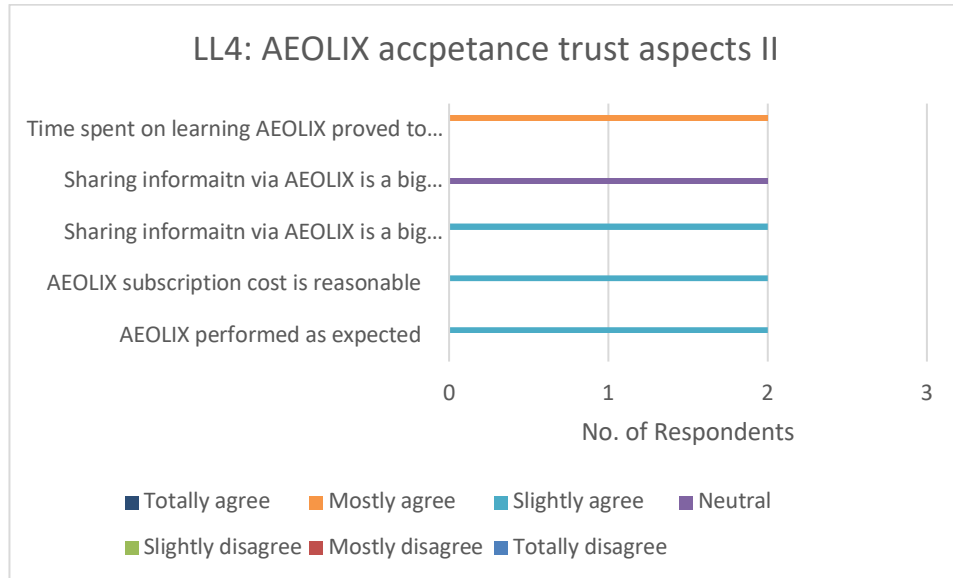


Figure 63: AEOLIX acceptance and trust aspects-II at LL4

All respondents 'mostly agree' to the claim that AEOLIX proved to be useful. However, the respondents have neutral view about sharing information via AEOLIX as a big hurdle in adoption of AEOLIX. This is because the respondents see that sharing information via AEOLIX have shown concerns among employees at their companies. At the end, respondents agree but 'only slightly' to claims that the cost of AEOLIX subscription is reasonable and it performed as expected at the living lab. Based on these results and above, we can conclude that AEOLIX has moderate acceptance and trust level at LL4.

5.5. LL5 Operational Impacts Assessment

LL5, also known as Danube River Inland Waterway, includes adjacent transport hubs for multi-modality purposes. This makes goods transportation over inland waterways as a part of complex transport system mainly because of changing infrastructure conditions such as water levels. This living lab consists of number of companies and organizations that adds to the complexity on information exchange and availability among various stakeholders and project beneficiaries. An example of beneficiaries include trucking company operating in the Danube countries which is part of the Road transport union or association. Most of the respondents of surveys for this report have five or more years of experience in their companies.

Stakeholders and beneficiaries within LL5 deals with number of varieties of products. These products include

- Products of agriculture, hunting, and forestry; fish and other fishing products
- Coal and lignite; crude petroleum and natural gas
- Metal ores and other mining and quarrying products; peat; uranium and thorium
- Food products, beverages and tobacco
- Textile and textile products; leather and leather products
- Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media
- Coke and refined petroleum products
- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
- Other non-metallic mineral products
- Basic metals; fabricated metal products, except machinery and equipment
- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
- Transport equipment
- Furniture; other manufacturing goods n.e.c.
- Secondary raw material; municipal wastes and other wastes
- Mail, parcels
- Equipment and material utilized in the transport of goods
- Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods n.e.c.
- Grouped goods: a mixture of types of goods which are transported together
- Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16
- Other Goods: any containerized cargo including dangerous goods; Liquid Petroleum products, liquid chemical products

Similarly, LL5 uses various types of cargos for inland water way including:

- Palletized goods
- Large freight containers

- Liquid bulky goods
- Other freight containers
- Pre-slung goods
- Mobile, self-propelled units
- Other mobile units
- Dry bulk
- Liquid bulk
- Project Cargo (Equipment)
- Containers

5.5.1. LL5 Business Aspects – Reduced Operational Costs

Business aspects at the operational level are mainly concerned with the reduction of various operational costs within LL5. There are number of services where LL5 has gained benefits from the use of AEOLIX. These KPIs has contributed to various services at LL5. A description of these services and the contribution made by KPIs is presented in the following sections.

Inland waterway Vessel ETA Update (Constanta - Regensburg navigable Danube):

Shipper (vessel owner or vessel operator) ETA Update for vessel arrival at destination port, by manual input in dashboard, in addition to initial ETA declared in River Information systems Carrier (logistical operator of forwarder) update of vessel arrival at terminal slot, by manual input in dashboard. The following Table 16 summarizes list of KPIs and how they related to perform ETA updates:

Table 16: KPIs impacting ETA update at LL5

KPIs	Description of KPIs (i.e. how specific KPIs contributed to ETA updates)
KPI_1: Average fuel consumption	<p>The optimization of trips schedule could produce a decrease of average fuel consumption with 20%. When arrival times are better scheduled, through improved notifications of ETA, the speed of the vessel until the next stop can be adjusted to consume less fuel.</p> <p>In addition, using AEOLIX platform in selecting intermodal options, a part of cargo transported by truck could be transferred to inland waterway freight.</p>
KPI_8: Average CO2 emissions	reduction of CO2 emission is directly linked to reduction of fuel consumption in KPI_1

KPI_9: Administration work	traditional communication (email, phone, SMS) to notify vessels position, ETA at destination port or terminal by shipper and carrier is consistently reduced by managing the ETA update in a single dashboard. The Shipper inputs the ETA once and the dashboard takes care of notifications based on preset authorizations. The Carrier does not need to use different sources of information to track vessels and can input terminal time slots for the benefits of the entire supply chain.
KPI_11: Level of service	Initial ETA is provided automatically from River Information Systems, additional ETA updates can be manually imputed by the shipper in the dashboard, for the benefit of the supply chain. Receiving updated information sooner allows for a better rendering of services of several players. The Shipper keeps the carrier informed easily and timely; contract owner can reduce risk with penalties at terminal drop-off/pick-up
KPI_14: Visibility / data sharing	By steering away from time consuming, strenuous traditional business communication methods (Individual emails, SMS, and calls) logistics users can focus on added value activities, reduce human errors and miscommunication, allowing an easier and timely communication with interested parties.
KPI_15: Interoperability	By increasing the number of ERINOT messages exchanged between Romania, Slovakia and Austria, ETA provided in RIS by vessels owners & operators, and subsequent ETA manual updates are shared for more voyages for the benefit of the Danube inland waterway market.
KPI_21: Acceptance and trust (degree of approval of a technology by the user)	AEOLIX becomes the go-to source of updated information, because it provides all-in information one for the logistic supply chain users, due to sustainable interconnections and legally approved user management

Automatic customizable notifications for the logistical partners in the supply chain (vessel operators, forwarders and Terminals)

Notification of vessel arrival times for cargo carriers and Port terminal; Notification of logistical operators about vessels new availability for voyages are included in this service. Following Table 17 summarizes KPIs contributing to the service.

Table 17: KPIs impacting automatic notification services at LL5

KPIs	Description of KPIs (i.e. how KPIs contributed to automatic customizable notifications for the logistical partners)
KPI_2: Average number of trips	Automated timely notifications of ETA, terminal time slots allow for a better management of the voyage, and of the available cargo space on vessels Publication and subscription to vessel rental availability allows for optimization

with consolidated cargo	of voyages and maximization of cargo space rental on vessels per typical voyages and routes
KPI_3: % of Empty runs	Publication and subscription of vessel rental availability allows for optimization of voyages and maximization of cargo space rental on vessels per typical voyages and routes
KPI_9: Administration work	From a single dashboard, the Vessel owner or operator will manage all his voyages and all his partners, and plan new voyages with existing or new partners, for the benefit of their business (less time, more visibility down the supply chain, more market exposure, while still maintaining commercial confidentiality).
KPI_11: Level of service	Forwarders can send personalized notifications to their terminal operators and other partners, resulting in serious financial savings and shortened delivery durations, by avoiding Penalty fees and preventing delays.
KPI_14: Visibility / data sharing	The platform enables both Vessel owners and forwarders to manage their ecosystem of partners (authorize access to voyage data, send messages, etc.)
KPI_21: Acceptance and trust (degree of approval of a technology by the user)	AEOLIX becomes the go-to source of updated information, because it provides all-in one information for the logistic supply chain users, due to sustainable interconnections and legally approved user management

Electronic Market Place for publishing and search of available vessels

Vessels owners customize visibility about availability for new voyages, by vessels capacity, origin and destination ports, dates and free cargo space. Additional positioning and contact info of vessels with active voyages may be included from vessel tracker services. Forwarders search for available ships on map and initiate dialogue by automatic messaging from the dashboard; Commercial agreements are closed via traditional methods, outside the platform. A summary is presented in Table 18 below.

Table 18: KPIs impacting electronic market place at LL5

KPIs	Description of KPIs (i.e. how KPIs listed below helped to electronic marketplace for publishing and search for available vessels)
KPI_2: Average number of trips with consolidated cargo	timely notifications of ETA, terminal time slots allows for a better management of the voyage, and available cargo space on vessels Publication and subscription of vessel rental availability allows for optimization of voyages and maximization of cargo space rental on vessels per typical voyages and routes
KPI_3: % of Empty runs	Typically export of bulk material implied going or returning with an empty vessel. The marketplace will generate consignments for the empty trip.
KPI_9: Administration work	seasonal shortages on the supply or demand of vessel capacity on the Danube and market penetration of small players can be improved by the generation of a marketplace based on publication and subscription of cargo space availability, generating more traffic

	on Danube, thus more business for players which reduce their business intelligence efforts and related administrative work to a great extent
KPI_11: Level of service	Forwarders can start to verify also in AEOLIX ships available for new voyages as disclosed by owners/operators that are existing partners or new potential partners, as long as they report in RIS and have created an AEOLIX user Additional positioning and contact info of vessels with active voyages may be included from vessel tracker services Forwarders search for available ships on map and initiate dialogue by automatic messaging from the dashboard Commercial agreements are closed via traditional methods, outside the platform
KPI_14: Visibility / data sharing	Vessel owners can take advantage of the ecosystem of partners that will continually grow in the AEOLIX platform, to establish faster new business with existing or new partners, through simple dashboard commands ("advertise my availability for new voyages")
KPI_21: Acceptance and trust (degree of approval of a technology by the user)	AEOLIX becomes the go-to source of updated information, because it provides all-in one information for the logistic supply chain users, due to sustainable interconnections and legally approved user management

In the next section, this report provides a summary of all KPIs measured by LL5 together with their achieved or estimated value. Furthermore, the report provides explanations related to the impact each KPI is having on various areas within LL5. An overview is presented in Table 19 below.

Table 19: KPIs benefits at LL5 (before & after AEOLIX)

KPIs	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %
<i>Reduction in fuel consumption (l/km; km/l; or l/tkm)</i>	20-25%	37240	29792	-20%
<i>Increase in number of consolidated trips</i>	25-30%	5%	10%	5%
<i>Decrease in % of empty runs</i>	5-10%	50%	20%	30%
<i>Reduction in average CO2 emission (g/km; l/tkm)</i>		98760.48	123450.6	-20%
<i>Administration work (minutes/hrs)</i>		5	3	-40%

The following Figure 64 shows the comparison of KPIs values targeted and achieved/estimated for LL5:

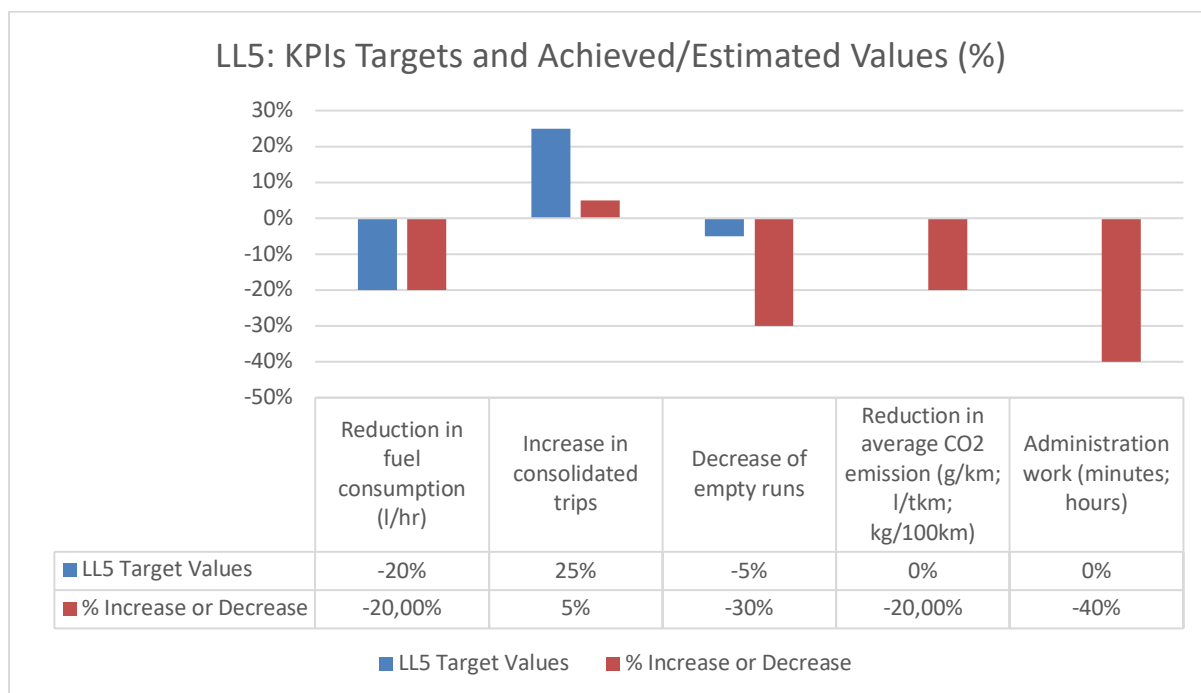


Figure 64: Summary of KPIs benefits at LL5 (target vs achieved)

Reduction in Fuel Consumption

LL5 had 140 l/hr of fuel consumption before AEOLIX which is reduced to 112 l/hr for vessels within the living lab. In terms of percentage, this reduction in average fuel consumption equals to 20% which meet the lower limit of target value 20-25% for multi-synchro modal transport. The optimization of trips schedule can produce a decreasing of average fuel consumption. When arrival times are better scheduled, through improved notifications of ETA, the speed of the vessel until the next stop can be adjusted to consume less fuel. In addition, using AEOLIX platform in selecting intermodal options, a part of cargo transported by truck could be transferred to inland waterway freight. The average consumption of one truck engine of 500 HP is 33l/h for a payload of 40t; so an inland waterway cargo of 1000t can replace 25 trucks consuming 825t of fuel. A summary of reduction in fuel consumption, before and after AEOLIX, presented in Figure 65 below.

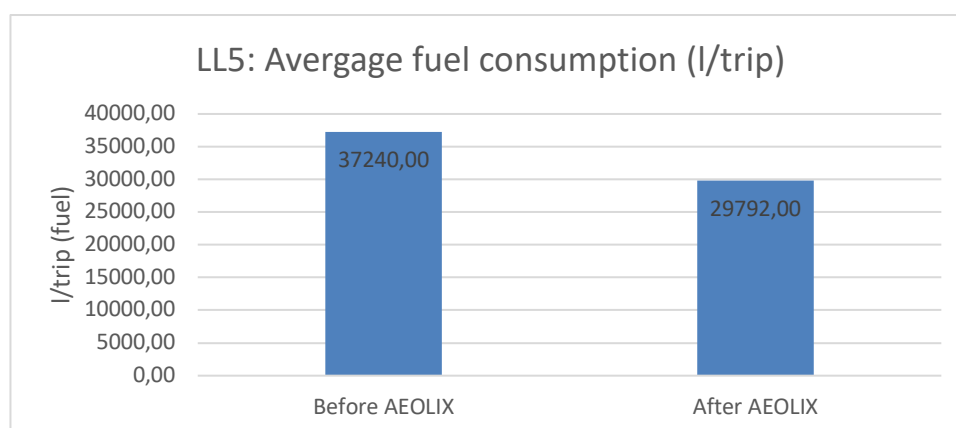


Figure 65: Reduction in fuel consumption at LL5 (before & after AEOLIX)

In addition, LL5 predicts that due to the optimal scheduling of vessels 1000t of cargo are expected to shift from road to inland waterways. This can be translated to approximately in 25 less 40t trucks in the road network. The total fuel savings of this modal shift can reach the 825t per hour. However, we did not include this figure to the average consumption because there is not a direct AEOLIX effect and there is not yet sufficient proof that this shift will be achieved.

Increase in Consolidated Trips

Consolidated trips before AEOLIX were 5% and after AEOLIX raised to 10% only. This means that increase in consolidated trips can only be raised by 5% which is way low than the target value of 25%. A small logistical operator can book between 50 and 60 voyages per year. The Lower Danube Cargo consist mainly of grains, thus transported as bulk shipments, on large barges. Consolidation could be obtained by combining different types of cargo, like containers with grains or ore. Through the publishing and subscription of shipping space availability, a small logistical operator can book a small portion of a barge to transport some containers together with a large bulk order. Estimation is based on business practices and orders history. NOTE: here consolidation was not considered booking several similar shipments from different clients in one convoy, like for example 3 companies needed to transport grains to the same location so a convoy with 3 barges was created, instead of just one barge. Though it would be too difficult to estimate/calculate how can AEOLIX impact, also. An overview of the situation, before and after AEOLIX, is shown in Figure 66 below.

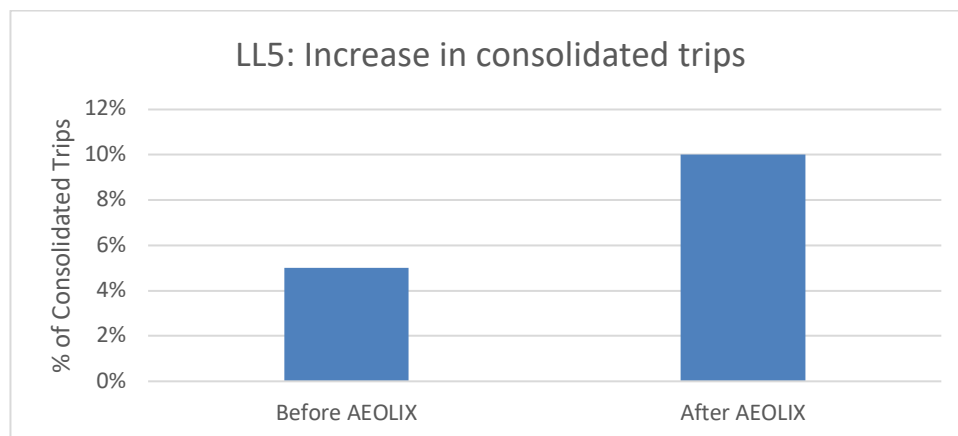


Figure 66: Increase in consolidated trips at LL5 (before & after AEOLIX)

Decrease of Empty Runs

On the contrary, decrease of empty runs is reduced by 30% against the low value of 5% only. Actual – an average 50% of voyages are empty runs before AEOLIX. After AEOLIX platform operation the amount of empty runs is expected to become 20%, due to consolidation of trips and more business generated by the marketplace function. An example of this includes a typically export of bulk material implied going or returning with an empty vessel. The marketplace will generate consignments for the empty trip. The table below shows before and after AEOLIX situations related to decrease in number of empty runs for LL5. Following Figure 67 provides an overview:

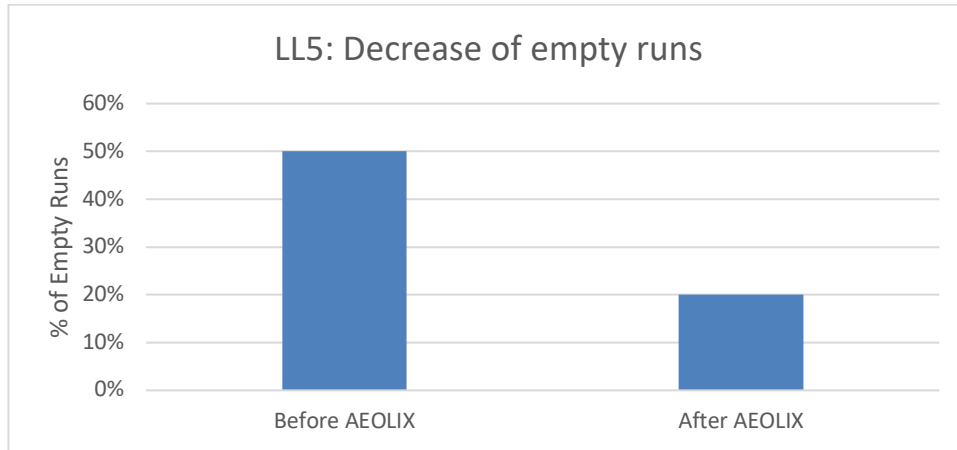


Figure 67: Decrease of empty runs at LL5. (before & after AEOLIX)

Reduction in Average CO₂ Emission

AEOLIX agreement has not set any value for reduction in average CO₂ emission. Yet LL5 has expected to reduce CO₂ emission by 20% with the use of AEOLIX. In total, a reduction of 7448l on average fuel consumption was observed. In terms of CO₂e emissions 24690,12 kgs less GHG were emitted after the implementation of the platform. Following Figure 68 shows before and after situation:

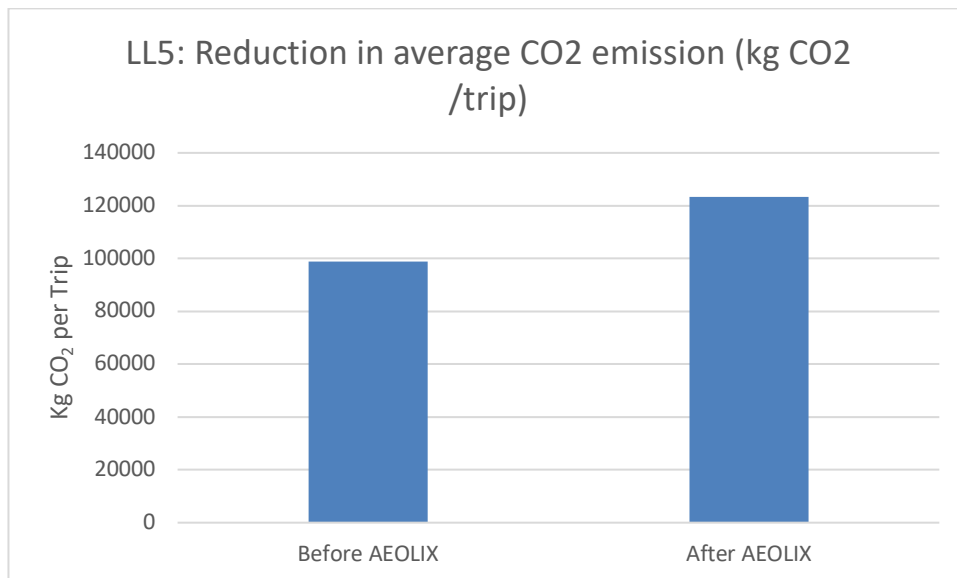


Figure 68: Reductin in carbon footprints at LL5 (before & after AEOLIX)

Administration Work

Similarly, AEOLIX has been quite helpful in reducing the efforts made for administrative work and achieved 40% reduction in time. Actual amount of hours used for administration work / marketing is rather big, depending on the type of role has an average of 5 hours a day. Implementation of AEOLIX platform especially can reduce the office man hours with 40% (can be reduced from 5 to 3 hours per day). Vessel owner can move the operational tracking and management for active voyages to an

automated centralized platform (AEOLIX) and replace traditional interaction methods (Individual emails, SMS, and calls). Management of ecosystem in one place; access to live data; automatic notification enabled. Increased visibility reduces redundant work of logistic operators. As an outcome, we expect fewer info sources need to be consulted. marketplace advertisement leads to improved level of business; finding business faster and with less effort. Following Figure 69 shows the situation before and after AEOLIX:

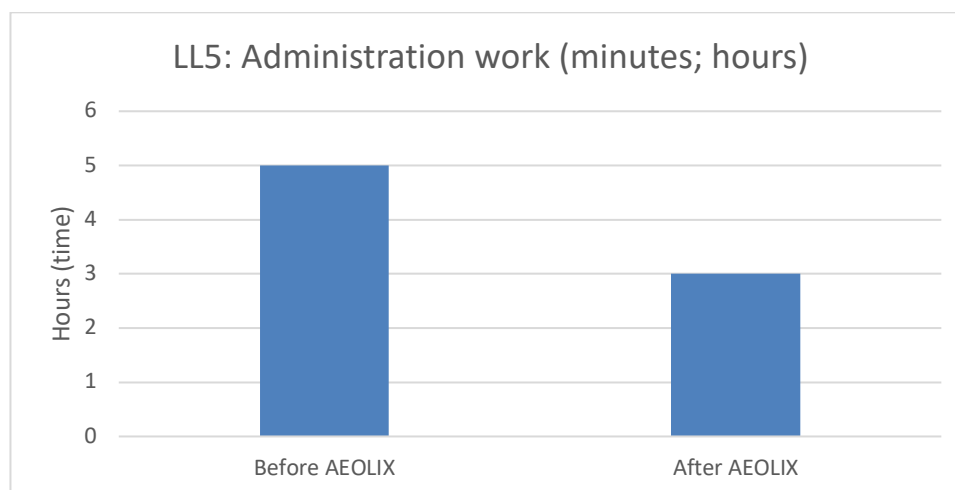


Figure 69: Administrative work benefits at LL5 (before & after AEOLIX)

The following Table 20 summarizes how each KPI has impacted or related or contributed to reduced operational cost within LL5:

Table 20: Reasons for KPIs benefits at LL5 (after AEOLIX)

KPIs	Main Reasons
Reduction in fuel consumption (l/km; km/l; or l/tkm)	Reducing of freight level (cost)
Increase in number of consolidated trips	Increased river tonnage (and thus transport capacity)
Decrease in % of empty runs	Better ROI through increased transport load and assignments.
Administration work (minutes/hrs)	The impact can be as far as cutting in half the personnel time for a logistic operator. No impact on the size of ship crew.
Level of Service	Forwarders can sent personalized notifications to their terminal operators and other partners, resulting in serious financial savings and shortened delivery durations, by avoiding Penalty fees and preventing delays.
Visibility / data sharing	Management of ecosystem in one place; access to live data; automatic notification enabled; marketplace advertisement leads to improved level of business, increased market-share and costs optimization

Interoperability	Increased visibility reduces redundant work of logistic operators
Acceptance and Trust	As an outcome, we expect fewer info sources need to be consulted thus reducing costs with personnel, and generating less human errors

These reductions or increase in the form of KPIs values lead to multiple costs reductions within LL5. These costs reductions bring about business value to LL5. A summary of these costs reductions is presented in Table 21 below:

Table 21: Summary of financial benefits at LL5 (before & after AEOLIX)

LL5	Target Value	Before AEOLIX	After AEOLIX	Achieved/ Estimated Value	Activities (Reasons)
C1. Logistics management (through trade management) - target 5.5-6%					
	5%	Senior role average 3 hours/day, with overhead and trade database subscriptions 20900 euro per year	10%-20% time reduction, 18810 euro per year	Results in 10% of cost	Market Investigation and Analysis: (Better access to market place; Reduction of time in searching for vessels owners to contact them for booking; Better voyage coordination)
C2. Logistics management (through trade management) - target 5.5-6%					
	5.5-6%	For a forwarding company, 4 employee, with average 15 euro per hour and 6 hours pay day (95040 euro per year)	89812 euro	Decrease 5.5%	Contracting transport Facilities of Vessels (Readily available Info about vessels characteristics; All technical and operational information in a single place, plus marketplace function)
C5. Loss, damage and delay (through reduced delays and claims) - target 1-3%					
	5%	15,000 euro in penalties per year on 200 trips	13500 euro in penalties	10%	Management of the transport chain, penalties payments (Better management of the transport chain generates reduction of delays and

					respectively demurrage ; Updates through ETA notifications leads to prevention of demurrage claims and other penalties)
C6: Insurance (reduction in premiums) more than 1%					
	5%	n/a	We don't know, the improvement in safety of navigation	2%	Company performance improvement, due to standardization of activities, may lead to decrease of premiums for the protection and indemnity P & I insurance - maritime insurance (Better premiums for the protection and indemnity insurance (maritime insurance) due to standardization of company workflows)

Trade Management Labor (through trade monitoring) – Target 5%+

For trade management labor, LL5 has gained benefits by reducing overheads on administrative costs. Through 'Market Investigation and Analysis', LL5 has estimated to reduced costs for senior role. This is calculated as follows: senior role average 3 hours/day, with overhead and trade database subscriptions 20900 euro per year. 10%-20%-time reduction, 18810 euro per year as shown in Figure 70 below.

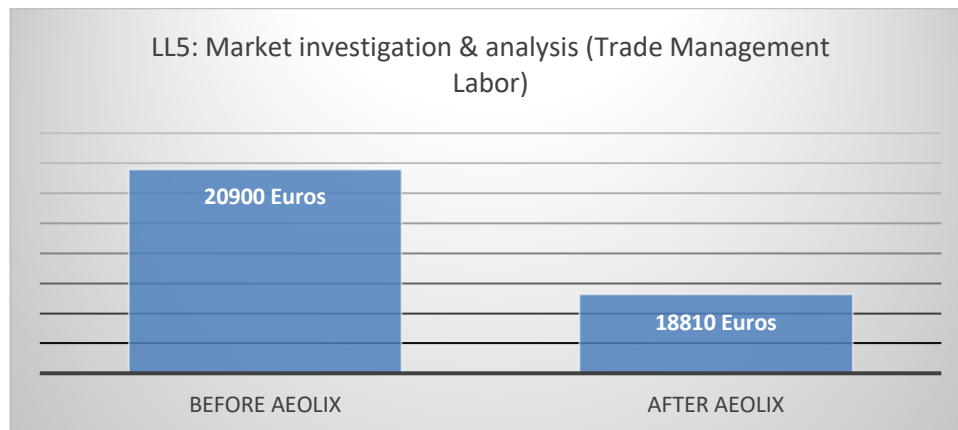


Figure 70: Trade management labor benefit at LL5 (before & after AEOLIX)

In terms of percentage, this accounts for 10% reduction in cost which is double the target value of 5%+. This target value was set during the beginning of AEOLIX project. Following Figure 71 shows percentages of target and achieved/estimated values.

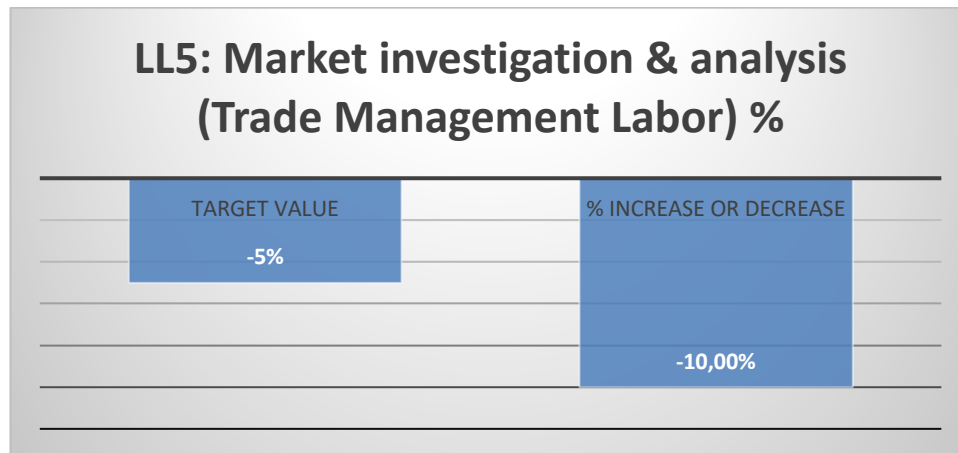


Figure 71: Trade management labor benefits in percentage at LL5 (target vs achieved)

Logistics Management (through trade management) – Target 5.5-6%

Logistics management is another area where LL5 was able to reduce cost through contracting transport facilities of vessels. The benefits, in terms of cost reduction, are calculated as: For a forwarding company, 4 employees, with average 15 euro per hour and 6 hours pay day (95040 euro per year). The benefits in Euros are shown in the Figure 72 below:

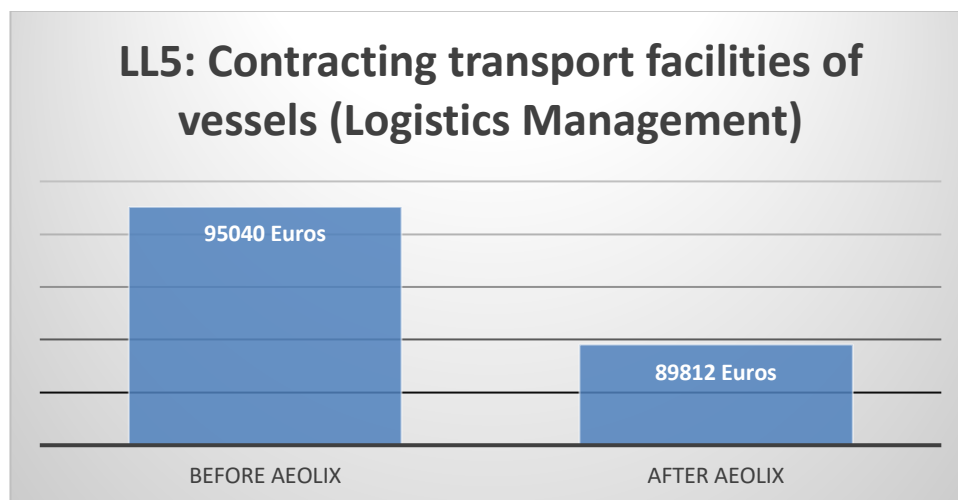


Figure 72: Logistics management benefits at LL5 (before & after AEOLIX)

In terms of percentage the reduction achieved the lower part of the target value of 5.5% reduction, and is shown in Figure 73 below:

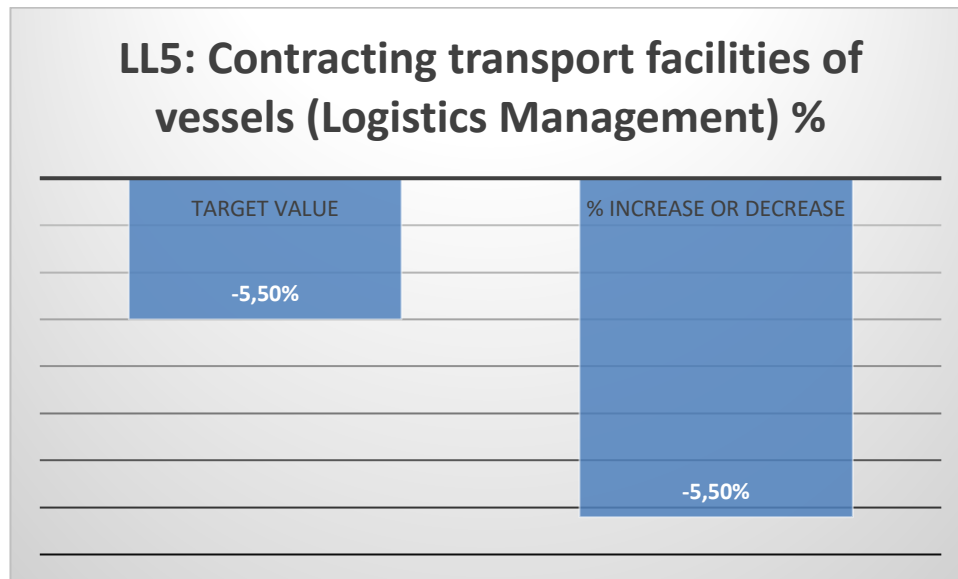


Figure 73: Logistics management benefits at LL5 (target vs achieved)

Loss, Damage and Delay (Reduced delay and claim costs) – Target 1-3%

Loss, damage and delay has been recognized as one of the most effective cost saving area for LL5. LL5 can reduce the cost through management of transport chain and penalties payments. This is calculated as: 15,000 euro in penalties per year on 60 trips. 13500 euro in penalties. The figures are shown in Figure 74 below:

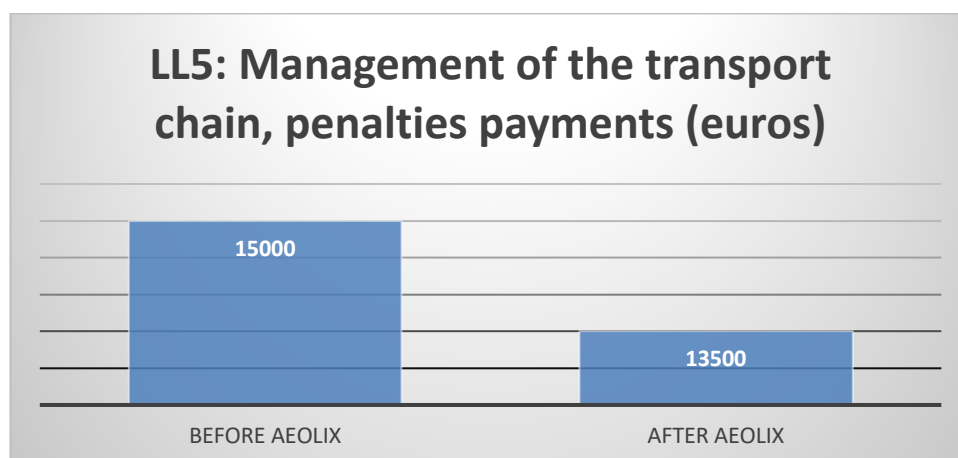


Figure 74: Loss, damage and delay benefits at LL5 (before & after AEOLIX)

In terms of percentage, the value is 10% reduction. This 10% reduction is a big achievement when compared to the target value of 1-3%. The comparison of percentages is shown in Figure 75 below:

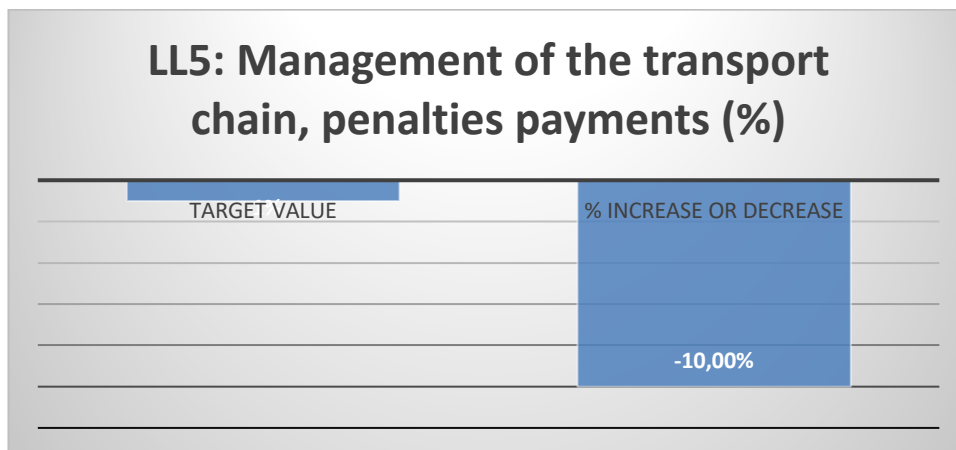


Figure 75: Loss, damage and delay benefits in % at LL5 (target vs achieved)

Insurance (reduction in premiums) – Target more than 1%

Last but not the least, LL5 is gaining benefits by 2% reduction in premiums. This is calculated in terms of company performance improvement, due to standardization of activities, may lead to decrease of premiums for the protection and indemnity P & I insurance (maritime insurance). LL5 do not know the improvement in safety of navigation though.

5.5.2. LL5 Environmental Aspects

One of the main goals with AEOLIX platform is to have positive impacts on the environment. Although, there are number of aspects related to the environment, we consider two major aspects – CO₂ emission and noise pollution. Fluid pollution and other pollutions have not been part of the study.

Reduced CO₂ Emissions

AEOLIX has helped LL5 to gain a considerable amount of reduction in CO₂ emission. According to calculated estimations, LL5 claimed to have 20% reduction in average CO₂ emission per trip together with 20% fuel reduction. The value of CO₂ emission per trip in kilograms before AEOLIX was 98760,48 and 123450,6 after AEOLIX having a reduction of 24690,12 Kg per trip. This shown in Figure 76 below:

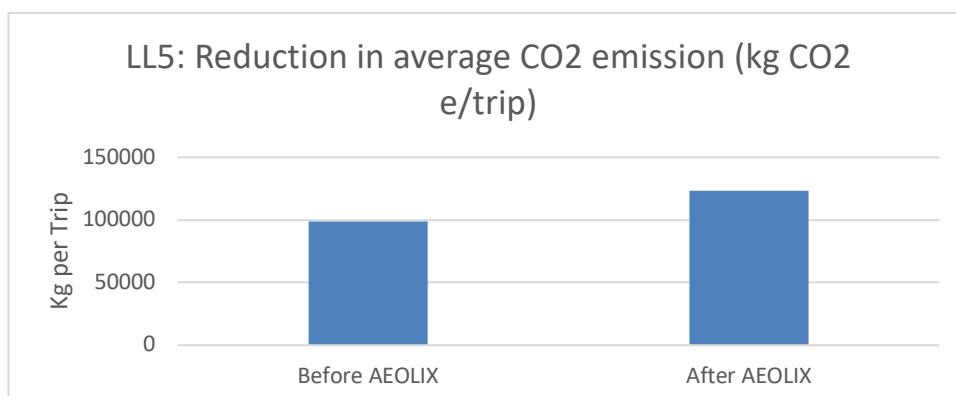


Figure 76: Reduction in carbon footprints at LL5 (before & after AEOLIX)

This reduction in CO₂ emission is considered to have a little but positive impact on environment as well as overall greenhouses gases emission. However, LL5 is not able to provide estimation regarding the impact of CO₂ emission on economy or financial benefits.

The following Table 22 summarizes the how each KPI contribute or related to CO₂ emission before and after AEOLIX:

Table 22: KPIs contributing to reduced carbon footprints at LL5 (before & after AEOLIX)

KPIs	Befor AEOLIX	After AEOLIX
Reduction in fuel consumption (l/km; km/l; or l/tkm)	CO2 emission depending on the existing fuel consumption	CO2 emission reduced due to reduction in fuel consumption
Decrease in % of empty runs		The impact on fuel consumption and CO2 emission is negligible, as the trips will happen anyway, with an empty or full vessel.
Reduction in average CO2 emission (g/km; l/tkm)	idem KPI Reduction in fuel consumption	idem KPI Reduction in fuel consumption
Visibility / data sharing	idem KPI Reduction in fuel consumption	idem KPI Reduction in fuel consumption

Reduced Noise Pollution

Noise pollution is considered as another important aspect for people dealing with environmental aspects. AEOLIX has helped 'To a great extent' in reducing noise for managers at office. Some examples of noise reductions include the use of AEOLIX for storing and sharing information instead of printing big documents and calling to various business stakeholders and customers. For this purpose, Dashboard has been of a great help, in particular. On the other hand, toolkit functionality has not been implemented and used by LL5. This is shown in Figure 76 below.

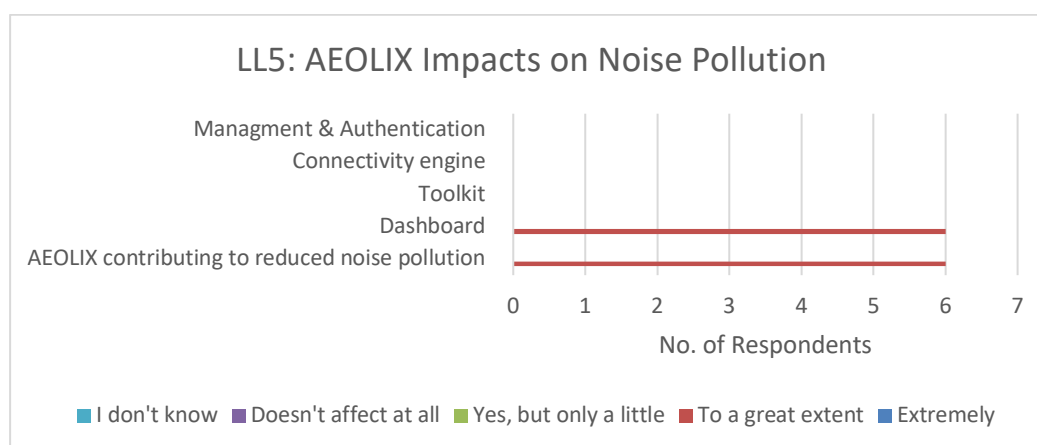


Table 23: AEOLIX impact on reduced noise pollution at LL5

Before AEOLIX, LL5 experienced high level of noise and stress due to ongoing phone conversation of logistical operators and vessels owners in the work environment. However, AEOLIX helped in significant reduction of noise, due to minimal phone conversations once information is managed in the dashboard.

5.5.3. LL5 Socio-economic Aspects

Socio-economic aspects include further sub-aspects including job, creation, SMEs empowerment, and quality of life at work for various employees. Results from each of the sub-aspects has been presented in the following sections:

Job Creation

Job creation has not been a major concern and is not applicable for LL5. For jobs creation at the operational level, this study has asked if AEOLIX has impact on two types of jobs in particular – drivers and operators' jobs. AEOLIX impact on job creation has been shown in the Figure 77 below:

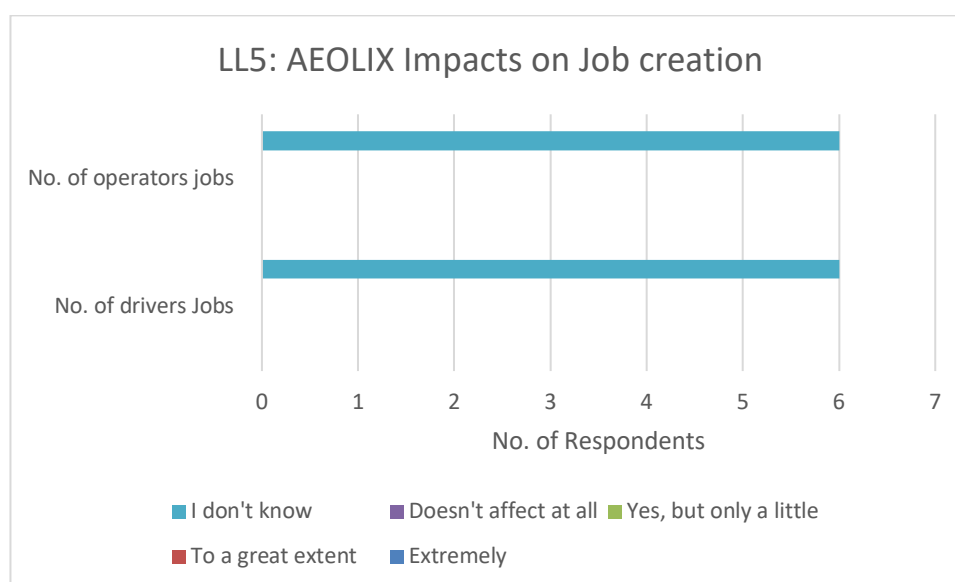


Figure 77: AEOLIX impact on job creation at LL5

The following Table 24 summarizes how each KPI is related to or contribute to job creation:

Table 24: Summary of KPIs related to job creation (before & after AEOLIX)

KPIs	Befor AEOLIX	After AEOLIX
Administration work	number of logistic operators matching the traditional communication level of effort	reduced time with administrative work can lead to reduction of employed operators/ operators getting involved in value added activities/opening of new positions for advanced activities
Visibility / data sharing	idem KPI Administrative work	idem KPI Administrative work

Interoperability		reduction of manual input of ERINOT messages (between River Information Systems) by staff of Public Authorities bodies responsible for Danube Traffic management can lead to job reductions
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SMEs Empowerment

SMEs empowerments include two major aspects: increase in market share and increased collaboration with larger organizations. The analysis of data shows a 'positive' results for both aspects. Five out of six respondents think that AEOLIX has or will help 'To a great extent' in increasing the market share especially for SMEs. While the last one thinks that AEOLIX has or will have positive 'but only a little' impact in increasing market share. For the sub-aspect of 'Increased collaboration with large organizations', all the respondents value AEOLIX impact 'To a great extent'. Therefore, we can say that AEOLIX has proven to be of a great value for SMEs within LL5. The distribution of SMEs empowerments has been shown in the Figure 78 below:

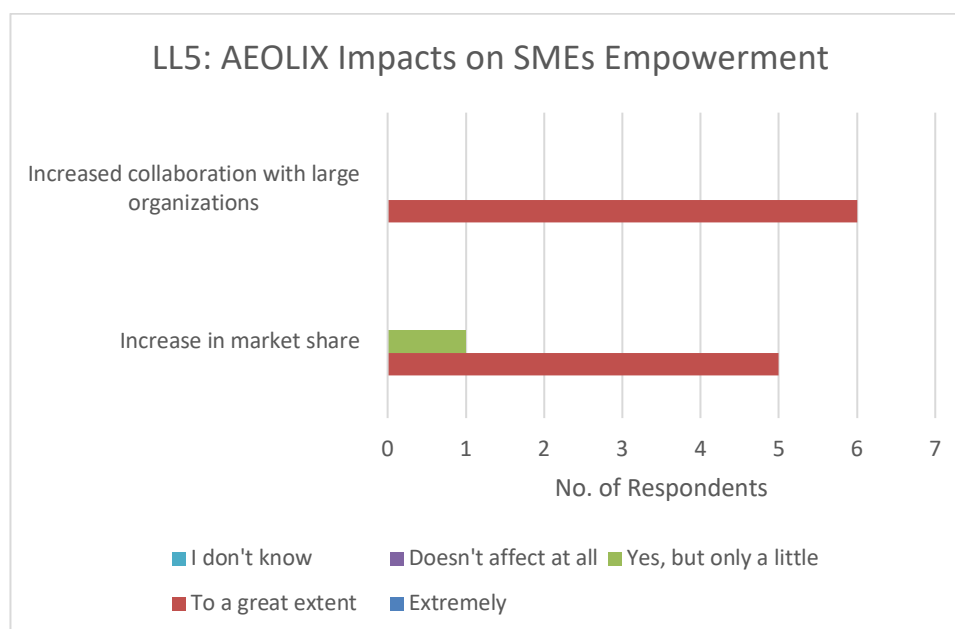


Figure 78: AEOLIX impact on SMEs empowerment at LL5

The following Table 25 summarizes how each KPI is related to or contribute to SMEs empowerment:

Table 25: KPIs and SMEs empowerment at LL5 (before & after AEOLIX)

KPIs	Befor AEOLIX	After AEOLIX
Increase of consolidated cargo		Increasing cargo quantity per voyage, allows rendering better services to customers
% of empty runs		Logistics management provided through AEOLIX can lead to

		improved freight movement, as well as an increase in financial flows for the parties involved
Administrative work	loss of business due to human errors and delays in communication	Reduction of human errors and miscommunication by improved visibility, and allowing an easier and timely communication with interested parties.
Level of service	Idem KPI_ administrative work	KPI_ administrative work + marketplace advertisement leads to improved level of business, increased market-share and costs optimization
Interoperability		Increased geographical area of AIS and ERINOT messages generates better level of service and business opportunities
Acceptance and trust		Acceptance and trust of all involved parties is likely to generate more business through sustainable interconnections and legally approved user management.

Improved Quality of Life

While job creation and SMEs empowerment has been the core part of socio-economic aspects, AEOLIX contribution to 'Improved quality of life' for employees and workers cannot be ignored.

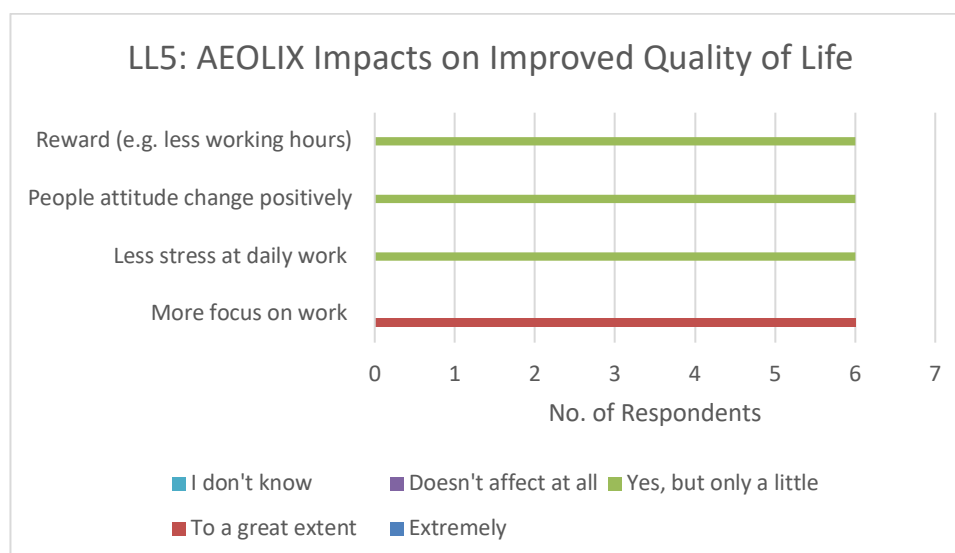


Figure 79: AEOLIX impact on improved quality of life at LL5

This study has explored a number of factors contribution to improved quality of life. These aspects are related to AEOLIX contribution with regard to 'more focus on work', less stress at daily work, change in people attitude positively, and reward (e.g. less working hours) for employees using AEOLIX. The

analysis of results has shown that AEOLIX have helped employees 'To a great extent' to put more focus on their work. While for the rest of the aspects on improved quality of life, AEOLIX still has contributed to 'a little' extent. A graphical representation of the results is shown in Figure 79 above.

The following Table 25 summarizes how each KPI is related to or contribute to improved quality of life:

Figure 80: KPIs and improved quality of life at LL5 (before & after AEOLIX)

KPIs	Befor AEOLIX	After AEOLIX
Average CO₂ emission		less air pollution on voyage for the ship crew
Administrative work	time consuming, strenuous traditional business interaction methods (Individual emails, SMS, and calls)	By steering away from traditional business communication channels logistics users can focus on added value activities
Level of service		Idem KPI_ administrative work
Visibility/data sharing	Idem KPI_ administrative work	Idem KPI_ administrative work
Interoperability		reduction of manual input of ERINOT messages (between River Information Systems) by staff of Public Authorities bodies responsible for Danube Traffic management can lead to less stress

5.5.4. AEOLIX Acceptance and Trust at LL5

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following

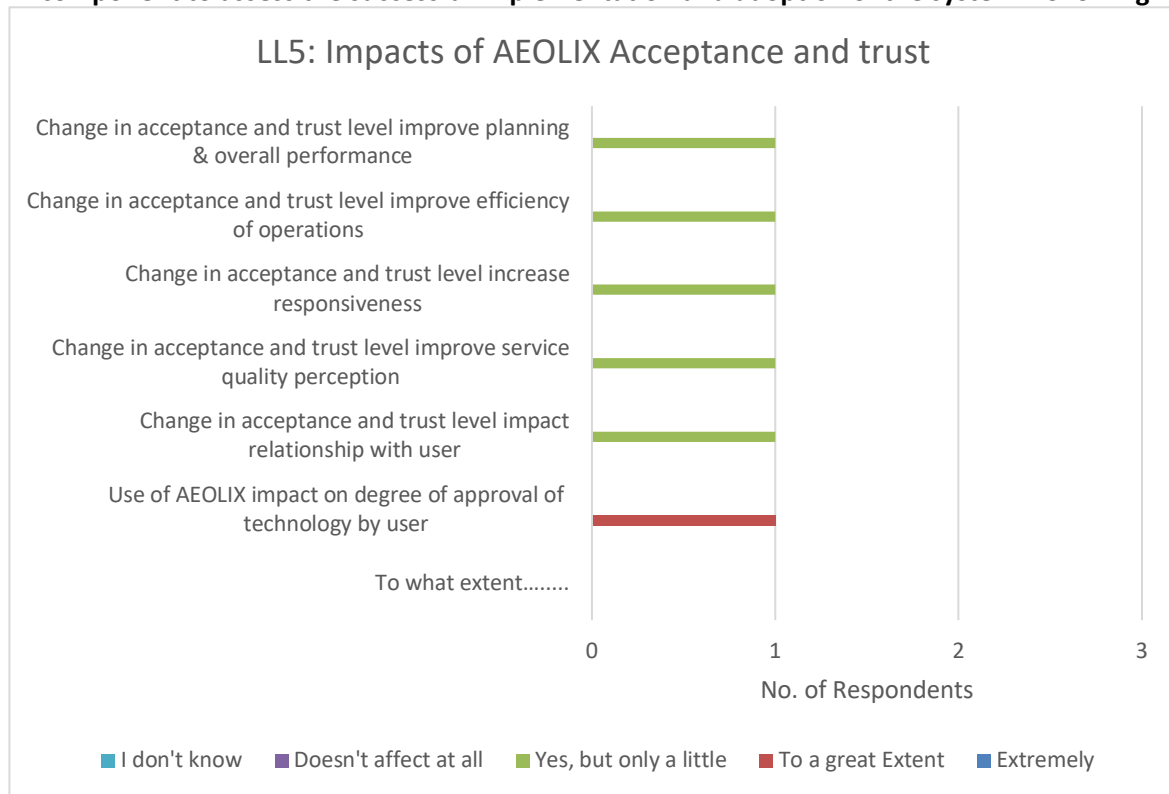


Figure 81 shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis show that LL5 evaluation manager thinks that AEOLIX use is directly related to the degree of approval to a great extent. Main areas where AEOLIX is contributing to a great extent include increased Visibility, access and management of information in one dashboard.

For rest of the aspects, AEOLIX acceptance and trust still play important role but only a little. Regarding AEOLIX acceptance and trust impact on relationship with user is associated with the quality of service rather than the technology only. Furthermore, management of visibility, authorizations of visibility, customized automatic notifications, and marketplace for new business are important associated areas where AEOLIX acceptance and trust improve the service quality perception, increased responsiveness and efficiency of operations within LL5. Last but not the least, improved visibility is the benefit gained by increase AEOLIX acceptance and trust within LL5.

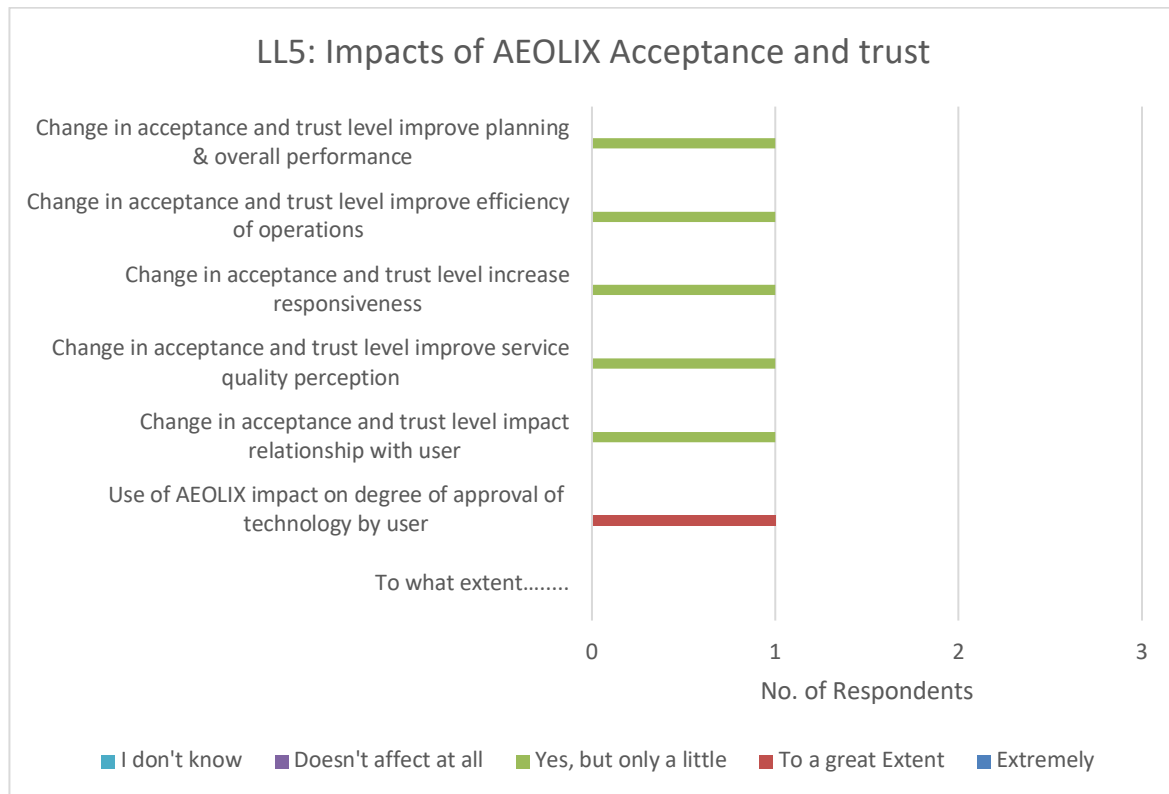


Figure 81: AEOLIX acceptance and trust impacts on various aspects at LL5

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 82 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL5 evaluation manager.

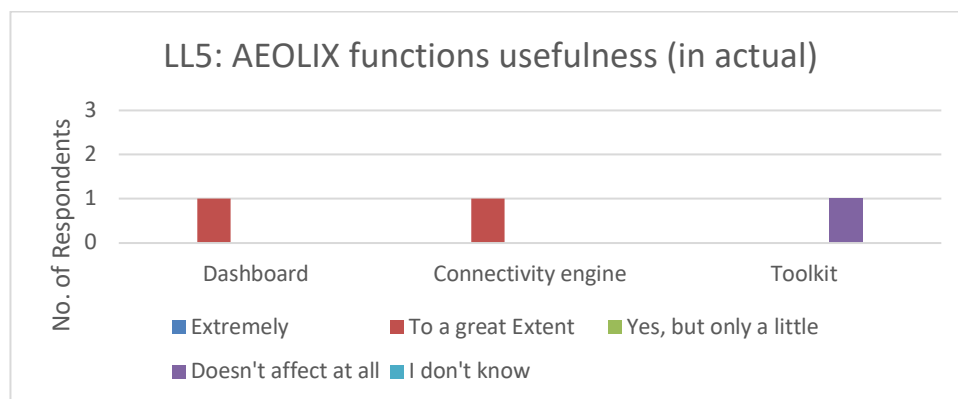


Figure 82: AEOLIX functions usefulness (in actual)

All three functions of AEOLIX are thought to be useful 'To a great extent'. This implies that the acceptance and trust on AEOLIX is quite high, since the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system.

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

Figure 83 below depicts that users shows interest 'To a great extent' on willingness to continue using Dashboard and connectivity engine. While LL5 doesn't use toolkit services of the AEOLIX platform.

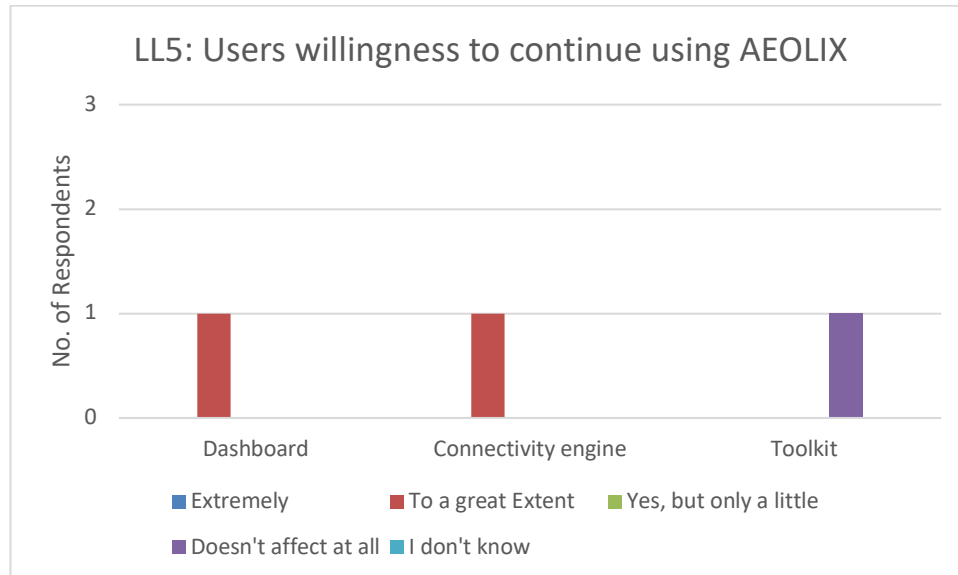


Figure 83: Users willingness to continue using AEOLIX at LL5

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results in Figure 84 show that users trust, but only a little on dashboard and connectivity engines. Although these functions have been proven useful to a great extent, but have quite low trust.

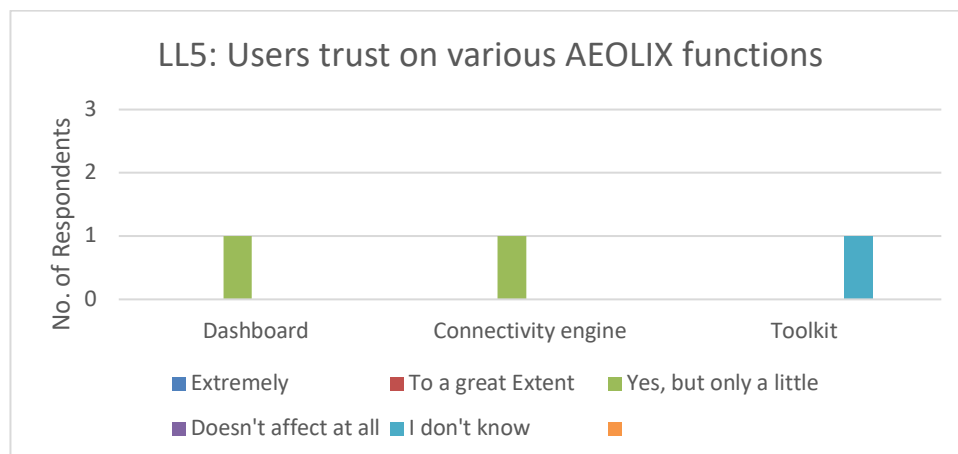


Figure 84: Users trust on AEOLIX functions

One of the reasons of low trust level is little use of AEOLIX system which is less than 40 hours per month for LL5. The reason for little use is also associated with late development and implementation of the complete AEOLIX system. Again, LL5 doesn't use toolkit services and is not relevant in this case.

Another important aspect for AEOLIX acceptance and trust is ‘ease of learning’. We ask the questions ***To what extent, users perceive that AEOLIX will be easy to learn? And To what extent AEOLIX actually proved to be easy to learn?***

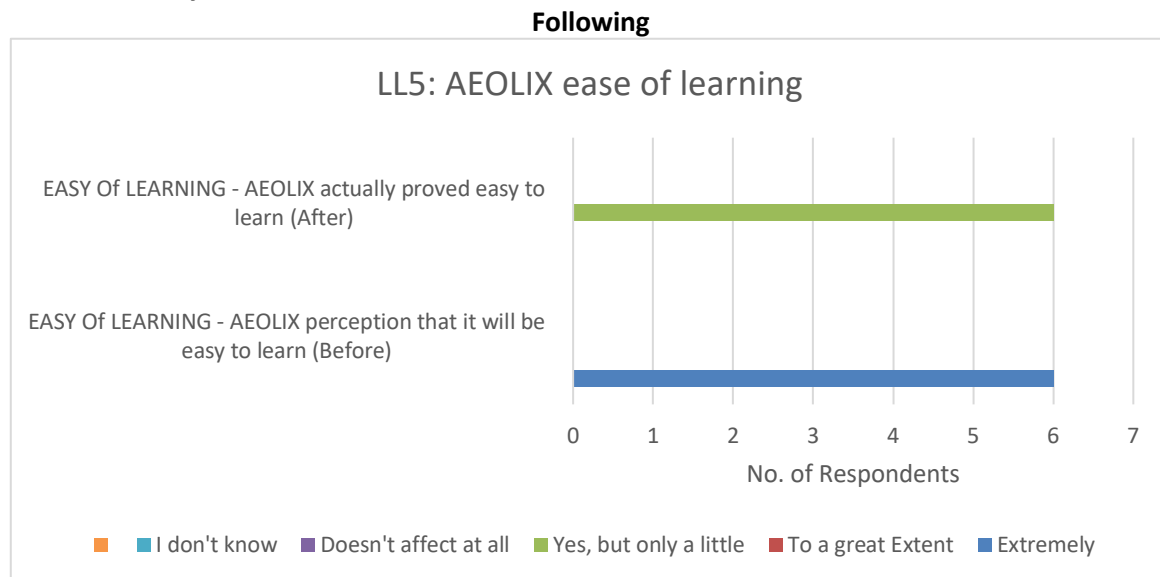


Figure 85 shows the results on ease of learning for LL5:

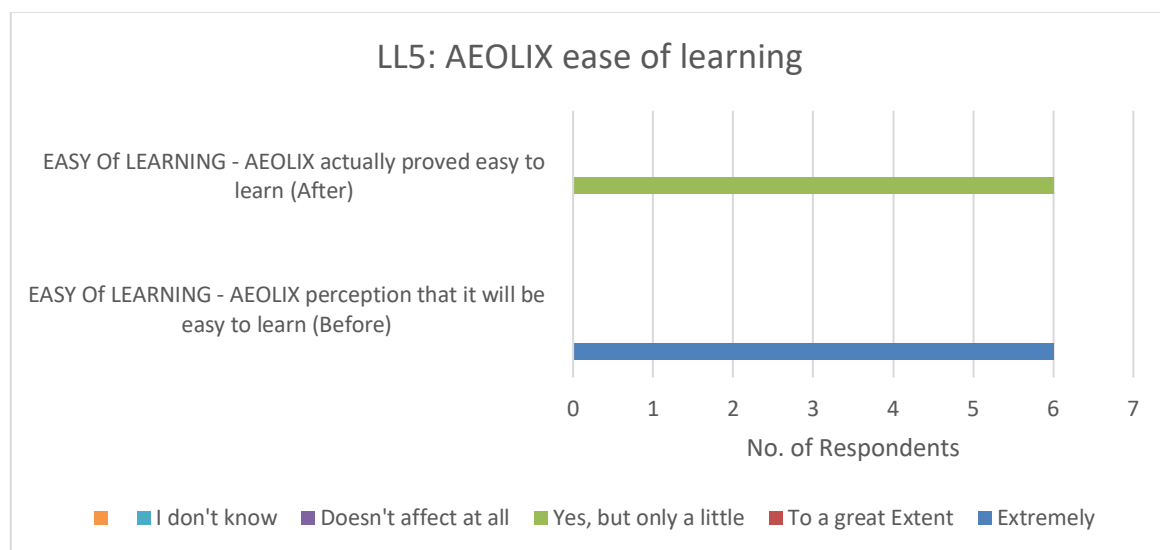


Figure 85: AEOLIX ease of learning at LL5 (perception vs actual)

Based on our response, all respondents within LL5 think that they perceived that it will be ‘extremely’ easy to learn the AEOLIX system. However, after facing challenges on implementation and deployment within the complex LL5 environment, respondents think learning was not so easy and they have to struggle in learning and using AEOLIX. This difficulty in ‘ease of learning’ effects AEOLIX acceptance and trust, negatively.

This study further asked about examples on easy of learning. Following Table 26 summarized the results:

Table 26: Specifics of AEOLIX ease of learning at LL5 (perception vs actual)

<i>AEOLIX Function</i>	<i>Before AEOLIX (Perception)</i>	<i>After AEOLIX (Actual)</i>
<i>In general, AEOLIX effects on daily tasks, in general perception</i>	Reduction of fuel consumption and improvement of waiting time for locks and formality.	Reduction of fuel consumption and improvement of waiting time for locks and formality.
<i>AEOLIX Dashboard effects on daily tasks perception</i>	<ul style="list-style-type: none"> • Consistent reduction of phone calls and emails • Consistent reduction of web browsing looking for available vessels • Consistent reduction of preparation of notifications 	<ul style="list-style-type: none"> • Partial reduction of phone calls and emails • Partial reduction of web browsing looking for available vessels • Partial reduction of preparation of notifications

This study further investigated number of aspects related to AEOLIX acceptance. The results are presented in the Figure 86 below:

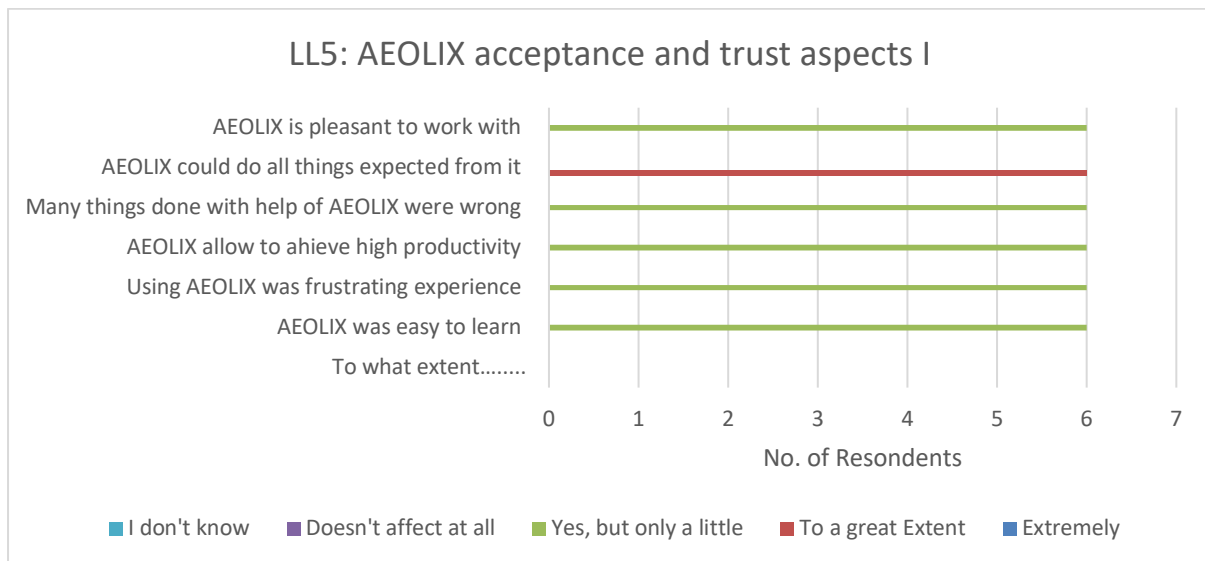


Figure 86: AEOLIX acceptance and trust aspects-I at LL5

This is clear from the results that many respondents agree 'To a great extent' with the claim that AEOLIX could do all things expected from it. This is directly related to the usefulness of AEOLIX. For rest of the aspects including frustrating experiences, high productivity, not fulfilling its intention, and pleasant to work with AEOLIX have been appreciated 'to a little extent' within LL5.

Last but not the least, we probed into further aspects related to AEOLIX acceptance and trust as shown in Figure 87 below:

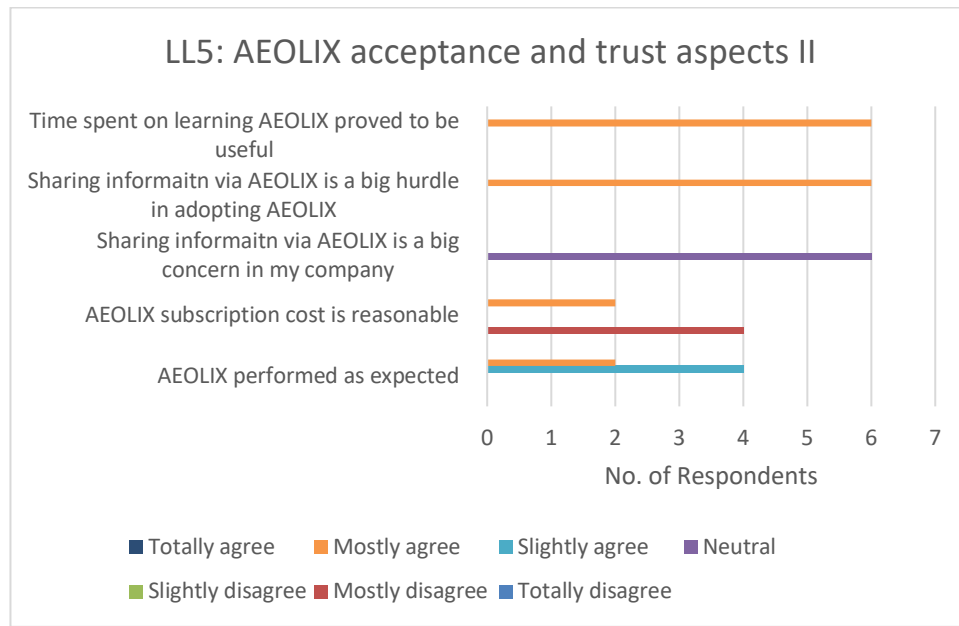


Figure 87: AEOLIX acceptance and trust aspects-II at LL5

All respondents ‘mostly agree’ to the claim that AEOLIX proved to be useful and sharing information via AEOLIX is a big hurdle in adoption of AEOLIX. While respondents in LL5 have a ‘neutral’ view on sharing information via AEOLIX as a big concern in their respective companies. However, we see a split on AEOLIX subscription cost – only two out of six respondents think that the cost reasonable (mostly agree) while the rest four think that the AEOLIX subscription cost is not reasonable (mostly disagree) for LL5.

5.6. LL6 Operational Impacts Assessment

Living Lab 6 (LL6), at Bordeaux mainly concerns with supply chain visibility and an example of multi-synchronization modal types living labs. The living lab has deployed AEOLIX platform and services in several port terminals on the Atlantic corridor in and around Bordeaux. Geoloc Systems (LL6 leaders), Cerema South-west and Novacom services are official partners within AEOLIX project. Besides these, LL6 has a number of associated partners. This living lab has collected data from various companies including Samat Company who owns trucks.

The objectives of the Bordeaux Living Lab are the improvement of data flow from shippers and operators (especially SME's) to the Bordeaux port and authorities with respect to required reporting in particular customs clearance and dangerous goods control. The main goal is to win time by proposing solutions optimizing the goods management during the key phases of the supply chain. This integrates services like estimated time of arrival, data interoperability and secured transfer of data including dangerous goods, appointment services by smartphone and container or bulk delivery and pick up management. By integrating port and road transport in an interoperable and paperless way, LL6 has the ambition to reduce the global time necessary for transport of goods. Multimodality is also key to the success of this living lab by proposing rail transport between 2 of the Bordeaux terminals which will permit the reduction of the number of trucks on the roads. Finally, an ambitious and complete mobile app was developed and proposed in priority to truck drivers but also to the other actors of the supply chain which are used to work outdoors. Some of the long term benefits include:

- Reduced risk to port and port communities with better access to dangerous goods content, location and faster clearance for access to port by Port Authorities
- Reduced processing time import of goods due customs clearance, enhanced logistics control
- Reduced waiting time for transportation assets while clearances are obtained, and hence reduction in associated CO2 emissions due idling, queuing of trucks.

Two companies have provided responses within LL6: company 1 with 400 and company 2 with 183 employees. The average experience of drivers in company 1 is 7 while in company 2 is 8 years. Company 1 mainly covers urban areas while company 2 covers both urban and rural areas. However, the distribution given by sea Invest Operators shows that 75% of the deliveries are local (i.e. delivery distance is less than 80 km) and 25% are non-local (delivery distance is more than 80 km). The places that are served during the work activity are shown in the Figure 88 below:

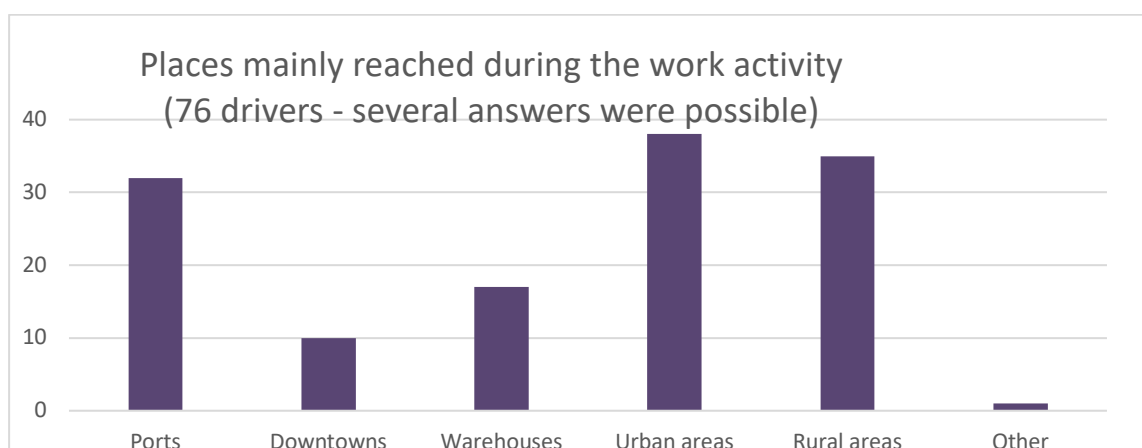


Figure 88: Distribution of areas covered by LL6

Both companies want good knowledge about the arrival time of products 'at the departure of the trip'. Both companies also want information about ETA in the middle of journey as well as information about routing all the time. It is noticeable that the last 5 km are very important for the delivery receiving organization and they want to have accurate geographical position of the delivery truck. The most important services for LL6 include the followings:

- Dematerialization service, Appointment service
- Estimation time arrival
- Real-time localization of the trucks of the company in circulation
- Knowledge on the availability of the receiving organization (port, warehouse, etc.)

The company has conducted survey with 76 drivers. The company has conducted survey with 76 drivers. Most of the drivers (40 out of 76) have 16 years plus experience while other 30 have 6-15 years of experience. There are only very few drivers with less than 5 years of experience. The distribution of their experiences is shown in Figure 89 below:

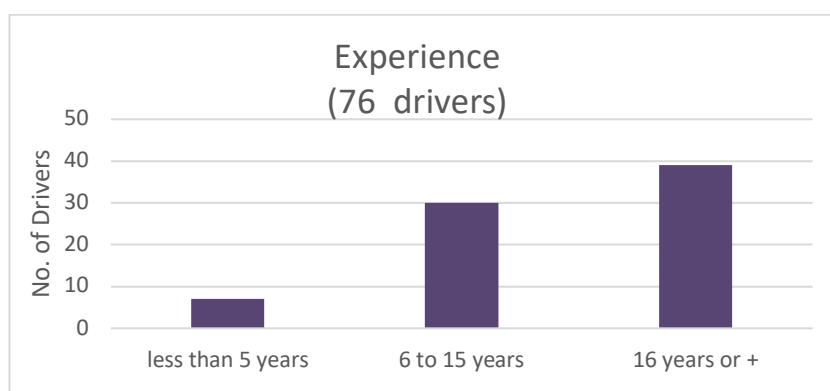


Figure 89: Distribution of drivers experiences at LL6

All of these drivers deliver different kinds of products including container truck, chemical tank, fuel tank, Bitumen tank, gas bottle flatbed, van, refrigerated truck, tipper truck and other flatbed trucks. Two thirds of the drivers use containers trucks and are subject to the containers zone under study in Bordeaux. The distribution of these trucks is shown in Figure 90 below:

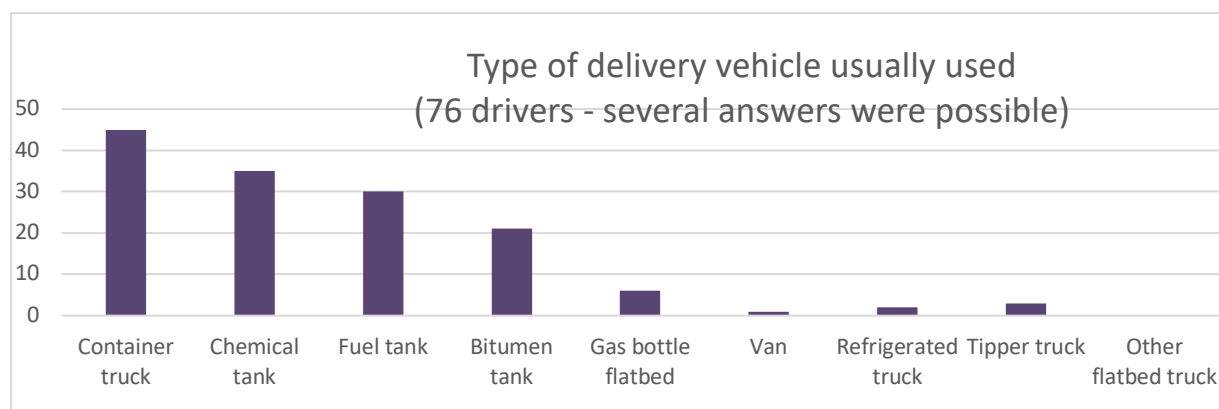


Figure 90: Types of deliver vehicles at LL6

A crucial factor for LL6 is average waiting time. Four times are important in this regard which are as follows:

- Average waiting time to enter the port
- Average waiting time to accomplish entrance papers
- Average waiting time at the loading / unloading zone
- Average waiting time to exit from the port

The average waiting time to enter the port ranges from 0 to 90 minutes with a mean time of 30 minutes to enter the port of Bordeaux. The most important area where AEOLIX has been helpful is to reduce the average waiting time by automating the registration process at the port. Following Figure 91 shows the distribution of average waiting time to enter the port:

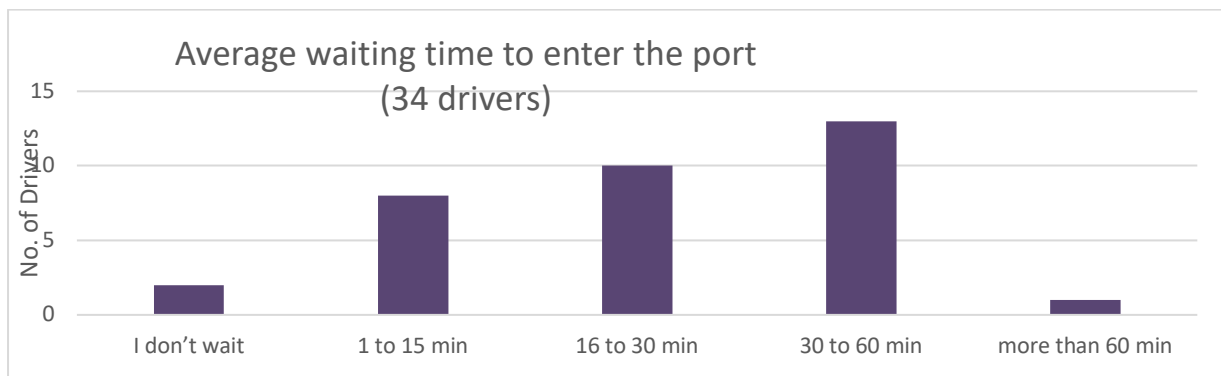


Figure 91: Distribution of waiting time for drivers to enter the port at LL6

The average waiting time for paper work related to administrative work ranges from 7.5 to 150 minutes with a mean value of 30 minutes. Most of the drivers have to wait 1-15 minutes, at least. While other are waiting up to half or even one hour. This is shown in Figure 92 below:

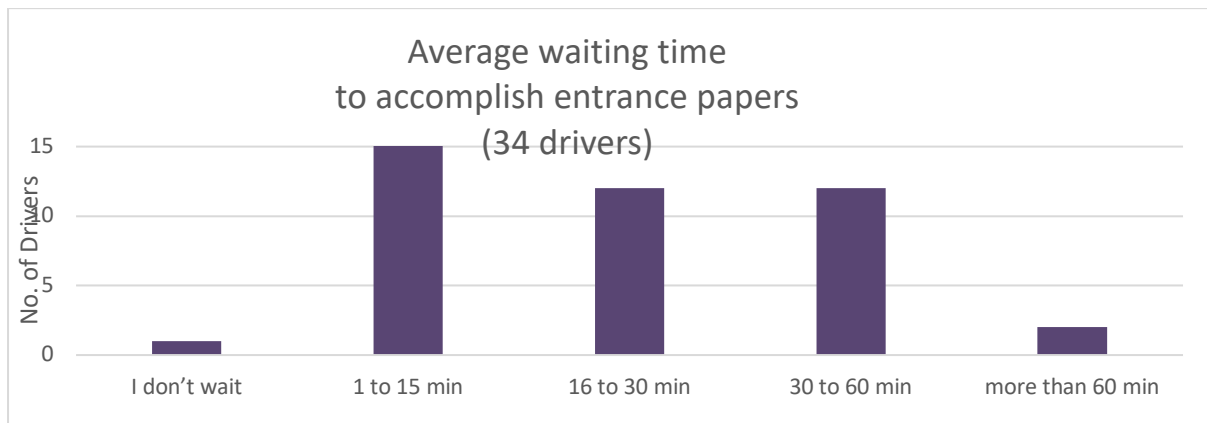


Figure 92: Distribution of time to accomplish port entrance papers at LL6

Similarly, the average waiting time at loading or unloading zone ranges from 7.5 to 90 minutes with a mean value of 30 minutes. Again the drivers have to wait up to 60 minutes, mostly. The distribution of average waiting time at loading and unloading zone is shown in Figure 93 below:

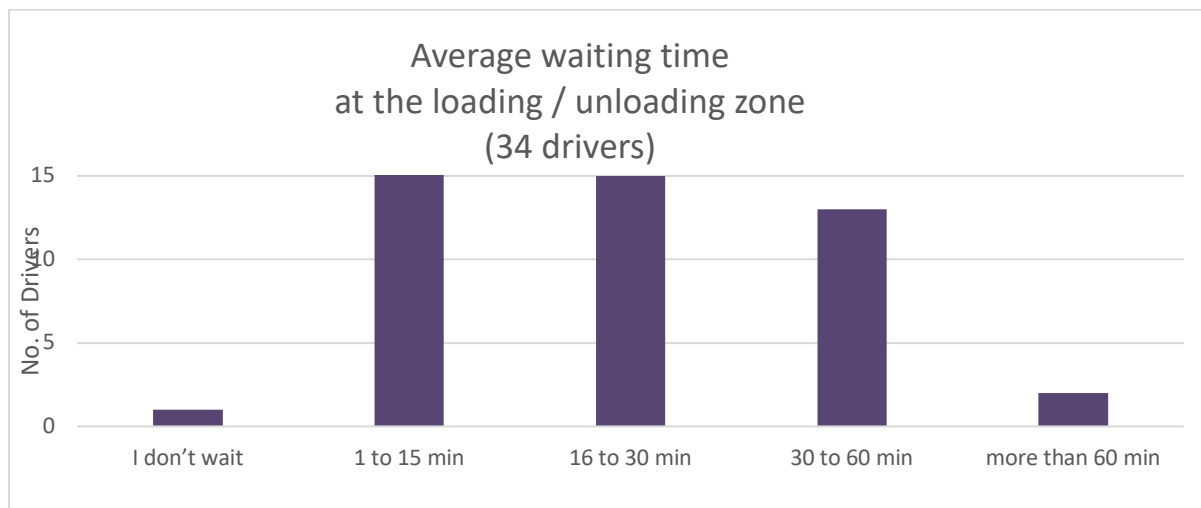


Figure 93: Distribution of average waiting time at loading/unloading zone within LL6

Finally, trucks also need to wait in order to exit the port. The average waiting time for exiting the port ranges from 0 to 45 minutes with the mean value of 7 minutes. This low mean value is due to the fact that most of trucks either do not wait or wait less than 15 minutes. A distribution of average waiting time to exit the port is shown in Figure 94 below:

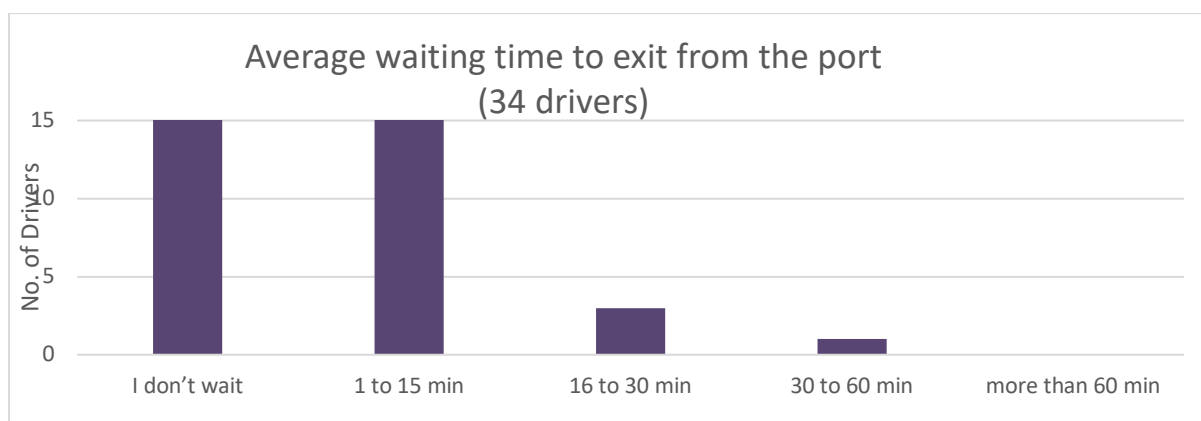


Figure 94: Distribution of waiting time to exit from port within LL6

This detailed analysis of the survey shows that LL6 is well aware of the situation at port of Bordeaux and associated partners. Keeping these facts in view, LL6 has chosen a list of KPIs where AEOLIX has impacted.

Analysis of results show that number of KPIs are impacting each aspect and sub-aspect of LL6 logistics activities. For example, reduced operational cost is affected by fuel consumption, waiting time of trucks at terminal, loading or unloading time, terminal productivity, administrative work, traffic avoidance or congestion, terminal handling efficiency, reliability, and acceptance and trust on AEOLIX system. Similarly, reduction in carbon footprints is dependent on fuel consumption, waiting time of trucks at terminal, unloading and unloading time, terminal productivity, CO₂ emission, avoidance in traffic congestion, and terminal handling efficiency. For a complete list of KPIs impacting socio-economic aspects of job creation, SMEs empowerment and improved quality of life, see Figure 95 below:

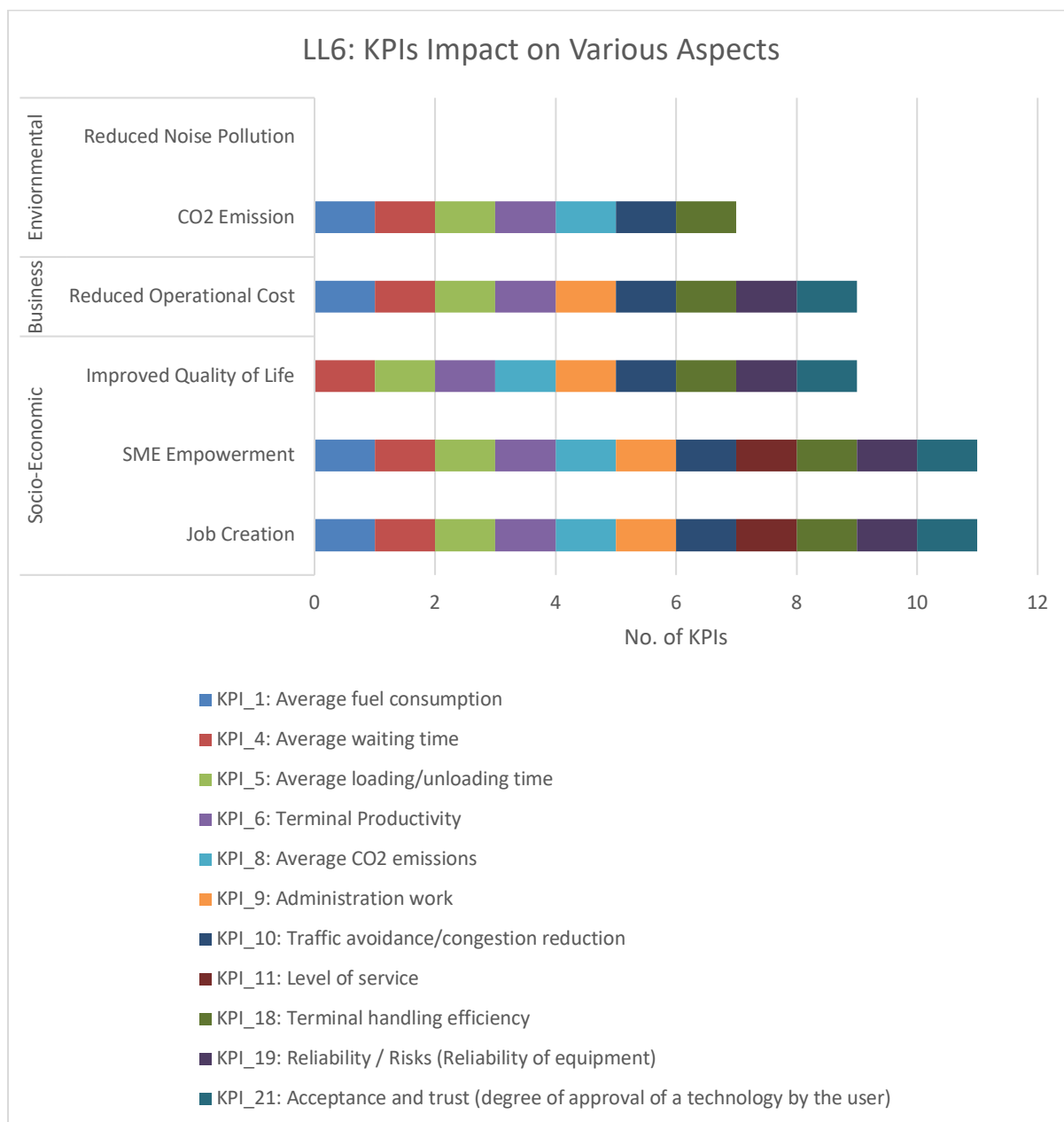


Figure 95: KPIs impact on various aspects at LL6

Before describing the AEOLIX benefits to various areas in the form of KPIs, it is good to know about different services at LL6 and how KPIs are related to these services. A summary of description is provided in the paragraphs below:

Slot Reservation

LL6 has used a tool permitting to reserve a slot for picking up or dropping off goods. Following

Table 27 summarizes how various KPIs are related to slot reservation:

Table 27: KPIs impacting slot reservation at LL6

KPIs	Description of KPIs (i.e. how KPIs listed below helped to electronic marketplace for publishing and search for available vessels)
KPI_4: Average waiting time	To measure the waiting time between end of load and start of trip, we can calculate the time difference between vehicle in the warehouse and vehicle start of trip. The list of missions from carriers, start/end of trip, start /end of loading are necessary in this case. To measure the waiting time between end of trip and start of unloading, we can calculate the time difference between vehicle in the geofence zone and vehicle leave of the port. We can make geofences on the entry and the exit of the port.
KPI_5: Average loading/unloading time	Same as in the previous KPI.
KPI_9: Administration work	See description of average waiting time in the above sections within LL6 information.

CO₂ Emission

Again, LL6 has used a tool permitting to calculate the CO₂ cost of a multimodal trip for the whole container or by article. Following Table 28 summarizes how various KPIs are related to CO₂ emission:

Table 28: KPIs and reduction in carbon footprints at LL6

KPIs	Description of KPIs (i.e. how KPIs listed below helped to electronic marketplace for publishing and search for available vessels)
KPI_1: Average fuel consumption	This indicator could be measured by Novacom system. The measures are updated every 5-10 minutes.
KPI_8: Average CO ₂ emission	This KPI could be calculated by Noscifel platform based on the measures of fuel consumption. The measures are updated every 5-10 minutes.
KPI_10: Traffic avoidance / congestion reduction	The estimated time arrival (eta) calculated by Novacom takes into account the traffic congestion information. A traffic congestion can be detected by comparing the location (highway, city road...) and the velocity of the truck (low or high velocity).

IMCTO Dashboard

Once again, LL6 has used IMCTO Dashboard which is an intelligent Multi Modal Cargo Transport Optimization Dashboard permitting the optimization of logistics. Following Table 29 summarizes how various KPIs are related to the dashboard:

Table 29: KPIs and IMCTO Dashboard at LL6

KPIs	Description of KPIs (i.e. how KPIs listed below helped to electronic marketplace for publishing and search for available vessels)
KPI_6: Terminal productivity	We will ask some carriers (e.g. Samat Group) and the port of Bordeaux.

KPI_18: terminal handling efficiency	This information could be obtained from Bordeaux port terminal. We are still trying to obtain such kind of information.
--------------------------------------	---

AEOLIX Global Services

his task consists in analyzing what changes are brought by AEOLIX to the daily management of a port. For terminal productivity, LL6 asked some carriers (e.g. Samat Group) and the port of Bordeaux.

Seamless Communication

LL6 has recognized that there is risk to lose information if the communication between AEOLIX application and mobiles is cut. Novacom Platform could generate a statistical service to determine the time / month when the AEOLIX service is in operation work or in failure status. So this information could be taken into account to measure a reliability. Of course the big risk is to have the service unavailable for long time.

5.6.1. LL6 Business Aspects – Reduced Operational Costs

AEOLIX impacts on business aspects at the operational level are mainly concerned with the reduced operational cost. The reduction in operational costs depends in which areas (in the form of KPIs) AEOLIX has been beneficial. A summary of these benefits for LL6 is presented in Table 30 below:

Table 30: Summary of KPIs benefits at LL6 (before & after AEOLIX)

Business impacts LL6	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Reduction in fuel consumption (l/km; km/l; or l/tkm)	20-25%	12000	9600	-20%	20% fuel consumption decrease (on target, lower end of range)
Increase in consolidated trips (#)	25-30%	LL6 didn't have information about the historical trips with consolidated cargo			
Decrease in % of empty runs ()	5-10%	LL6 didn't have any data or information about empty runs			
Reduction of waiting time for trucks in the terminal (hrs)		2	1	-50%	Waiting time reduced by 50%.
Reduction of average loading/unloading time (hrs)		20	20	0%	No impact on loading/unloading time.
Increase of terminal productivity (hrs)		1,5	1	-33%	33% decrease in time spent in terminal.
Reduction in average CO2 emission (g/km; l/tkm)		36000	28800	-20%	20% CO2 reduction achieved.
Administration work (minutes/hrs)		20	5	-75%	Dramatic (85%) decrease in time spent on administration work.

A summary of various KPIs targets and achieved or estimated values is presented in Figure 96 below:

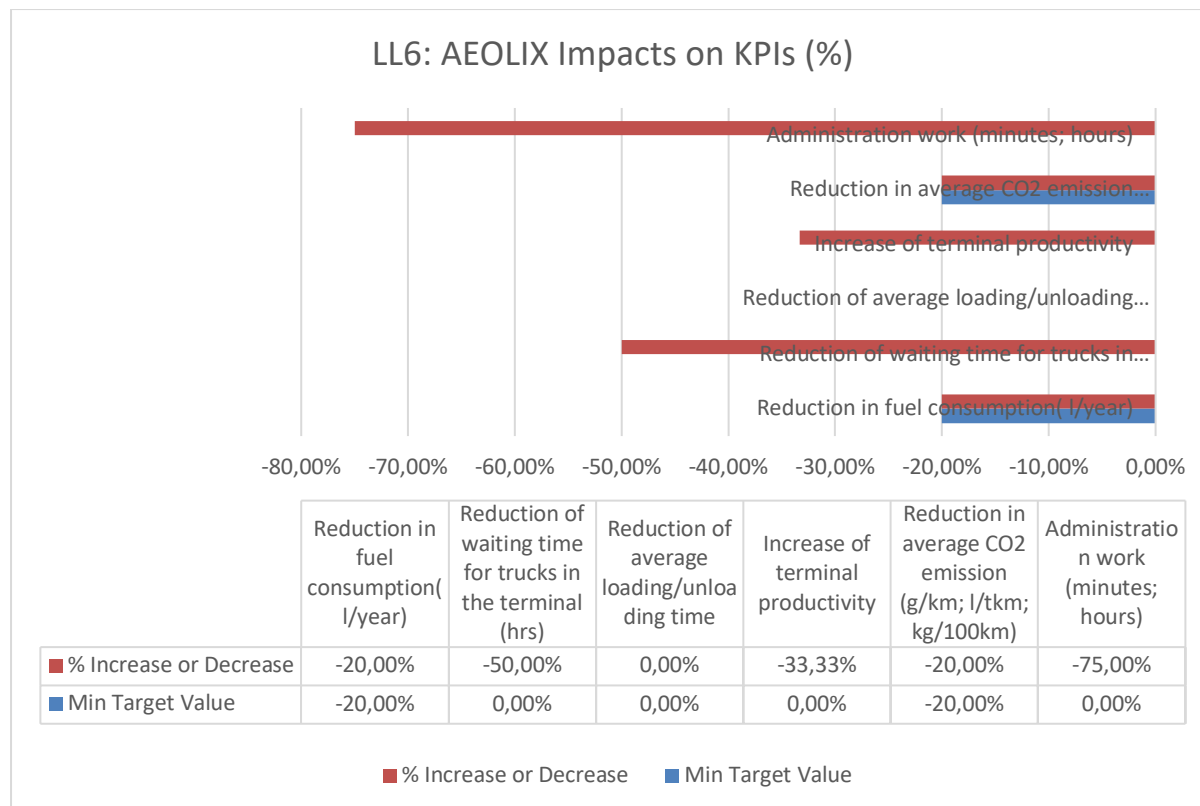


Figure 96: KPIs benefits in % at LL6 (target vs achieved)

Reduction in Average Fuel Consumption

AEOLIX has been quite helpful in reducing average fuel consumption at LL6. The average fuels consumption before AEOLIX was 12000 liters per year and after AEOLIX 9600 liters per year. This account for 20% reduction in the fuel consumption. The target achieved by LL6 is comparable to the set target range of 20-25%. Most of the benefit came by reducing time spent in traffic. Following Figure 97 shows the difference in reduction of average fuel consumption before and after AEOLIX:

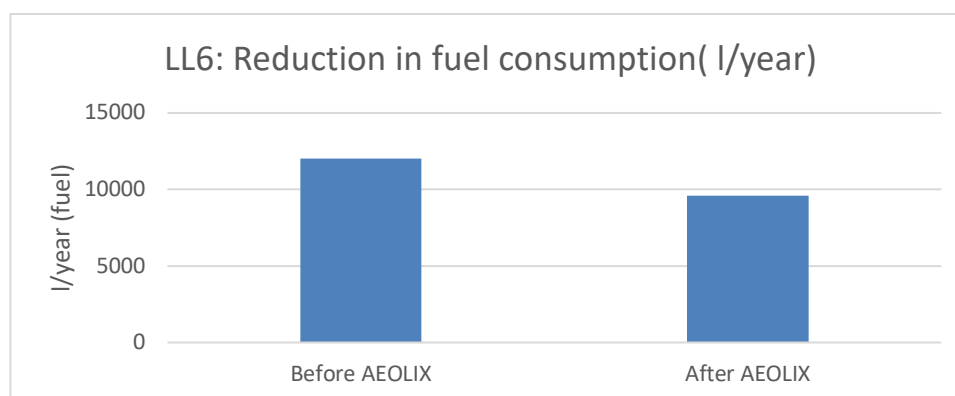


Figure 97: Reduction in fuel consumption at LL6 (before & after AEOLIX)

Reduction in Waiting Time for Trucks in the Terminal

AEOLIX has been quite helpful in reducing the average waiting time for truck at the port of Bordeaux. A lot of time is wasted on the paper work confirming ID and other clarifying procedures when a truck arrive at the port. This costs a lot of money for companies within LL6. On average, AEOLIX was able to reduce the waiting time for trucks from 2 hours to 1 hour. A summary of difference in time before and after AEOLIX is shown in Figure 98 below.

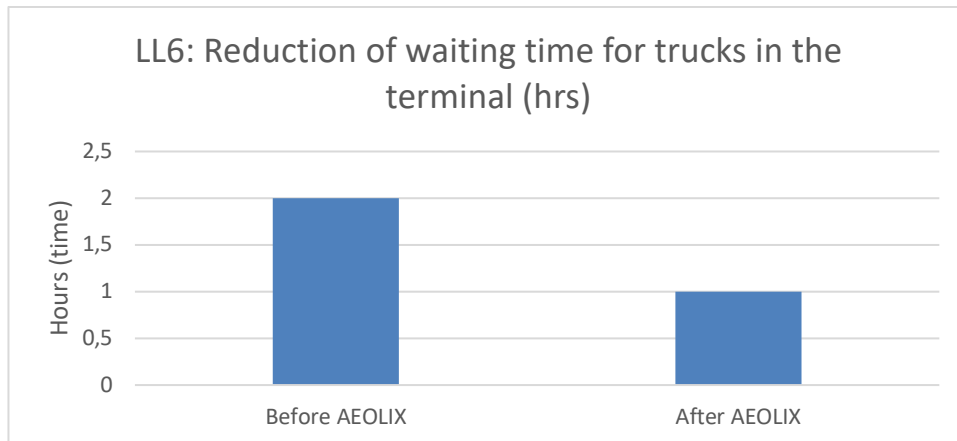


Figure 98: Reduction of waiting time at LL6 (before & after AEOLIX)

Reduction in Average Loading / Unloading Time

AEOLIX has no significant impact in terms of reduction in average loading and unloading time. The time taken before and after AEOLIX is the same. One important aspect here is that LL6 is not much concerned about loading and unloading time at the dock area. The living lab is more concerned with waiting time of trucks entering and leaving the port. Following Figure 99 shows the values for average loading and unloading time before and after AEOLIX.

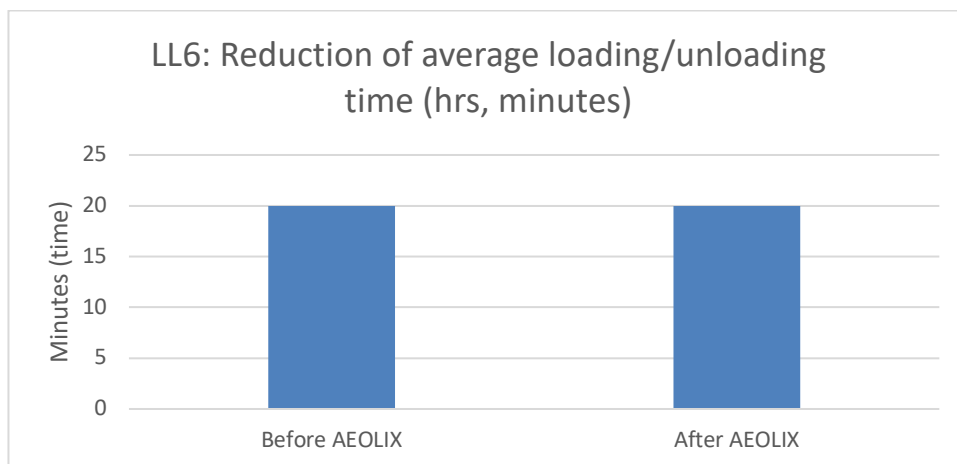


Figure 99: Reduction of loading/unloading time at LL6 (before & after AEOLIX)

Increase of Terminal Productivity

Increase in terminal productivity is one of the areas where AEOLIX has been most beneficial. For LL6, the terminal productivity is mainly concerned with reducing truck throughput time. With the help of AEOLIX, LL6 was able to estimate a saving of 33% of time though no target has been set for this KPI for the living lab. In other words, this can be said that LL6 has increase terminal productivity by 33%. A summary of values before and after AEOLIX is presented in Figure 100 below.

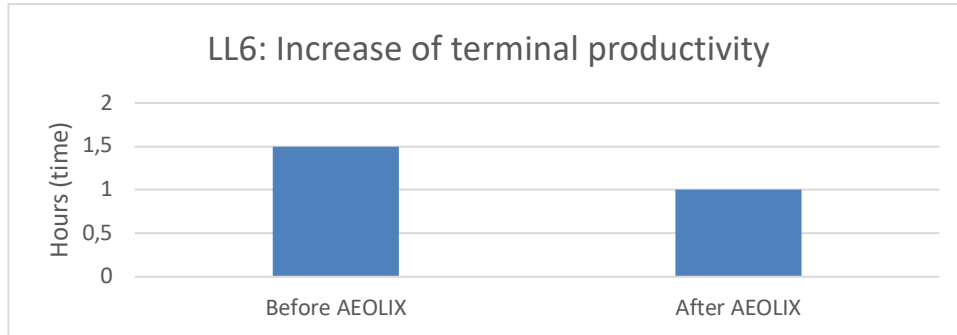


Figure 100: Increase of terminal productivity at LL6 (before & after AEOLIX)

Administration Work

AEOLIX has been very helpful in reducing the time spent on various administrative activities including the handling of vehicles. This is especially critical when these vehicles are entering or leaving the port. A lot of time has been spent on paper work and confirmation as required by the administrative authorities. After using AEOLIX, a lot of amount of time is saved by providing updates regarding trucks and drivers on the system. For example, the administrative work that took 20 minutes before AEOLIX can now be done in 5 minutes, at the most. This allows LL6 to save 73% of the time spent on administrative work related to the trucks handling at the port of Bordeaux. Following figure shows time spent on administrative work before and after AEOLIX.

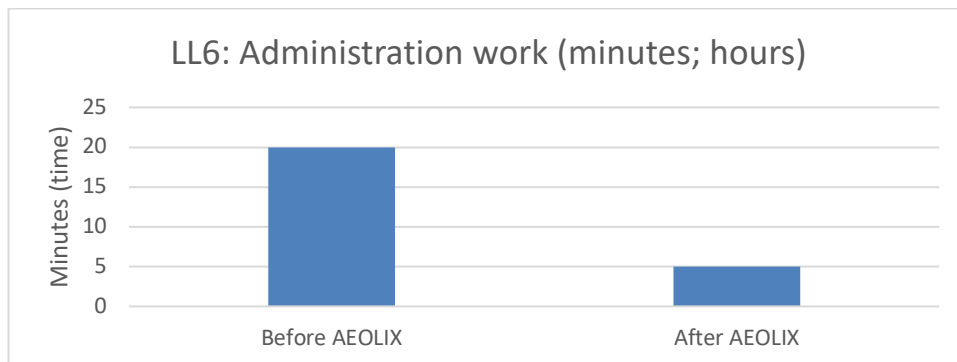
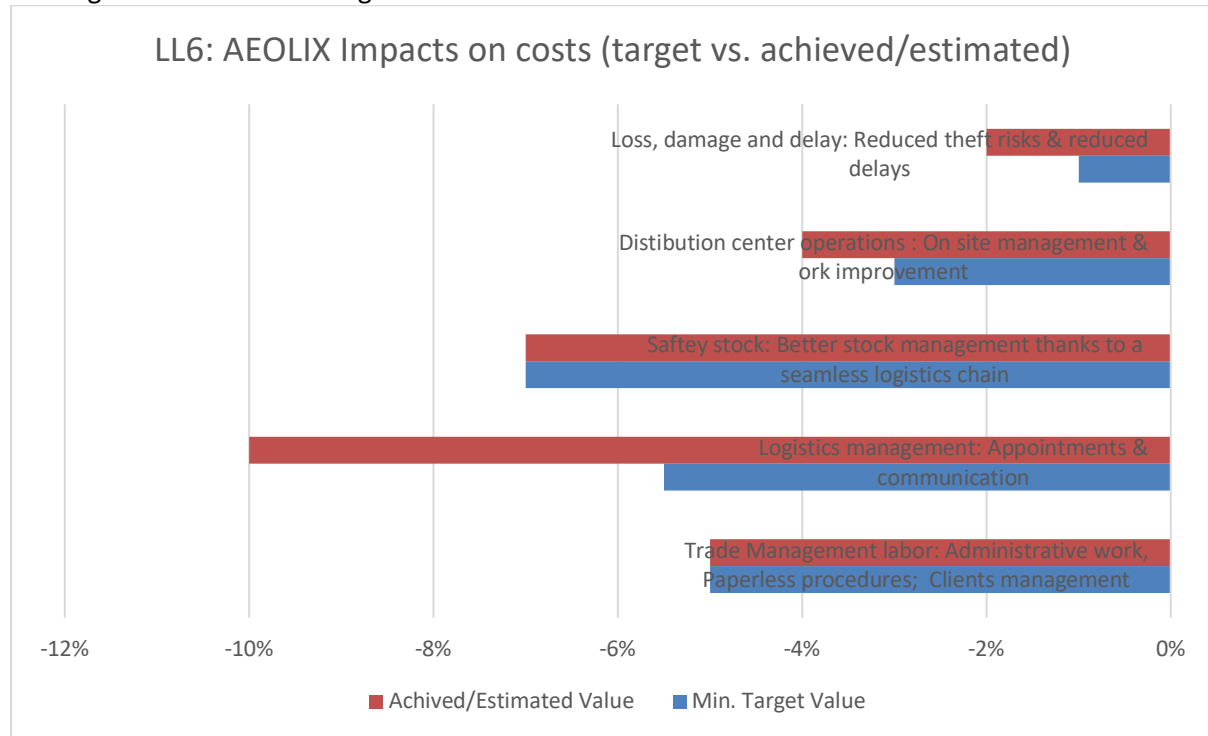


Figure 101: Administrative work benefits at LL6 (before & after AEOLIX)

AEOLIX Impacts on Costs – Target vs Achieved

All the benefits obtained (in the form of KPIs) have helped LL6 to save various costs. These costs include trade management labor, logistics management, safety stock, distribution center operations,

as well as loss, damage, and delay. A summary of financial benefits achieved or estimated against the set target value is shown in figure below.



Trade Management Labor

Trade management labor cost is achieved through trade monitoring. LL6 has estimated to achieve 5% reduction in the cost related to trade management labor. A target of 5%+ has been set for this type of cost, and LL6 is optimistic to achieve the target value. Most of the savings occur by saving time on administrative work meaning no idle time for employees, paperless procedures – again saving time and clients management.

Logistics Management

For logistics management, a target of 5-6% in cost reduction was set for all living labs using AEOLIX. LL6 was able to save up to 10% of the time spent on appointments and communication about the status of the deliveries.

Safety Stock

On one hand, safety stock ensures available of goods whenever required. On the other hand, this results in extra costs and occupation of valuable resources. Within AEOLIX, a target of 7-10% was set at the early stage of the project for all living labs. LL6 has provided an estimation to meet the lower limit of target, that is, saving costs by 7%. The main reason for reduction in cost possible through better stock management which is possible due to seamless logistics chain. This seamless logistics chain is used by various stakeholders to share information and communicate with each other.

Distribution Center Operations

Distribution center operations cost is related to the cost of facilities and labor. A target of 3-5% was set at the beginning of AEOLIX project for all living labs. LL6 has estimated savings up to 4%, hence meeting the target value. Main costs are saved for the activities of on-site management and work flow improvements in LL6.

Loss, Damage and Delay

Claims and delaying costs are the main part of the loss, damage and delay cost. Although this type of cost is considered low but the cost itself is non-productive cost. The cost is paid to establish the reputation in the market and have smooth business relationship with other stakeholders. A target value of 1-3% was set for this type of cost. Against this target value, LL6 has estimated to save up to 2% in cost reduction mainly related to the delays of deliveries.

5.6.2. LL6 Environmental Aspects

There are number of KPIs impacting the two environmental aspects – CO₂ emission and noise pollution. A list of these KPIs is shown in Figure 102 below.

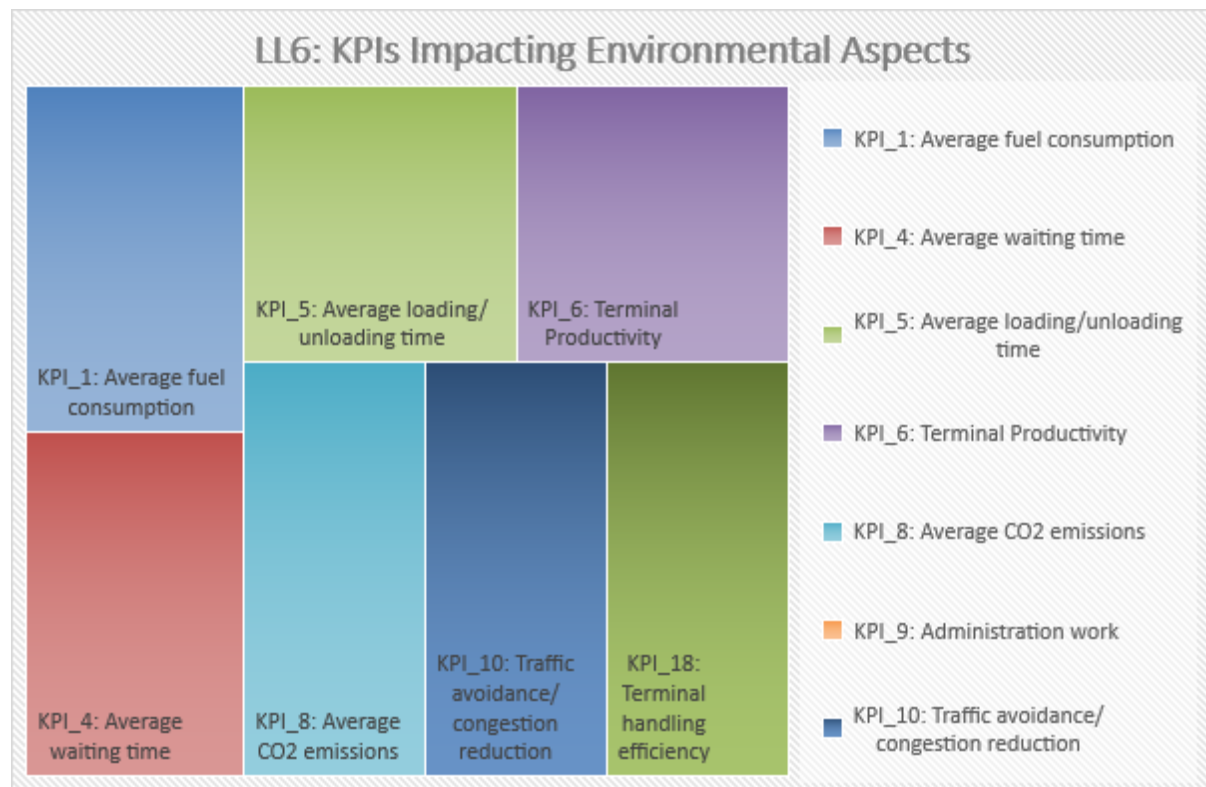


Figure 102: KPIs impact on environmental aspects at LL6

Reduced CO₂ Emissions

CO₂ emission has high and direct impact on environmental aspects especially related to greenhouse gases for LL6. The living lab calculated CO₂ emission before AEOLIX as 36000 Kg/year and after AEOLIX

as 28800 Kg/year. This accounts to 20% reductions in CO₂ emission for LL6 with the use of AEOLIX. The main benefits come with seamless information sharing in the real time resulting in reducing the time spent by trucks in traffic. The difference in CO₂ emission is shown in Figure 103 below:

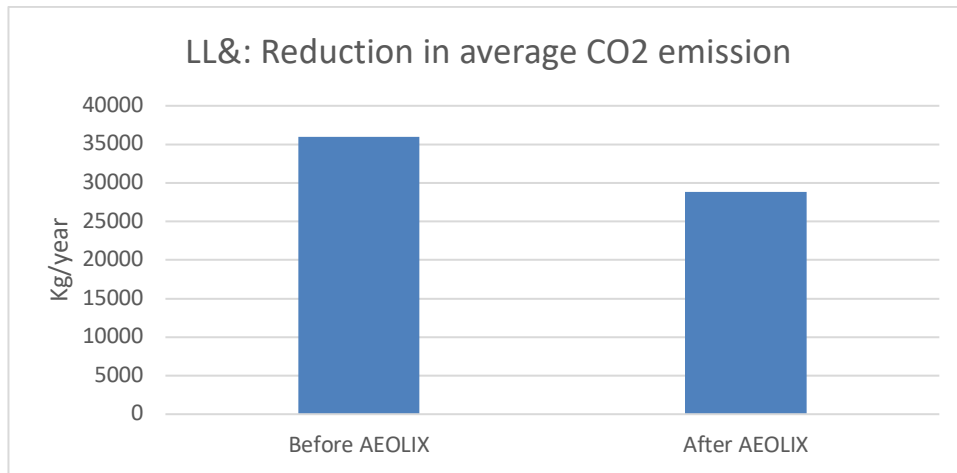


Figure 103: Carbon footprints at LL6 (before & after AEOLIX)

Reduced Noise Pollution

No data available

5.6.3. LL6 Socio-economic Aspects

There are number of KPIs impacting socio-economic aspects of job creation, SMEs empowerment and improved quality of life at LL6. An overview of KPIs impacting each of the aspects is presented in Figure 104 below:

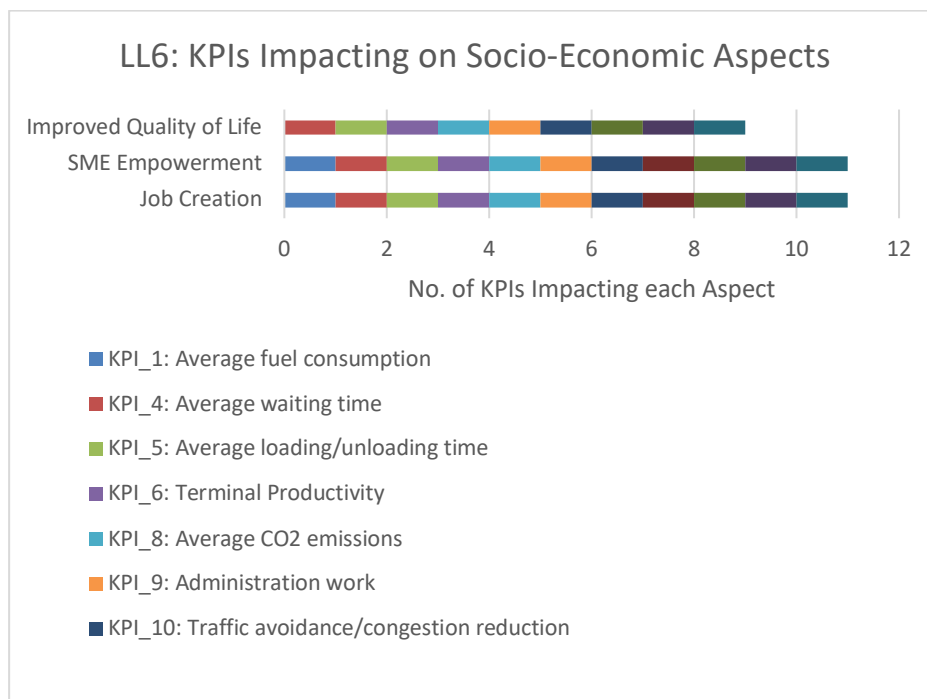


Figure 104: KPIs impacting socio-economic aspects at LL6

Job Creation

No data available to what extent AEOLIX has contributed to job creation within LL6.

SMEs Empowerment

No data available on to what extent AEOLIX has contributed to SMEs empowerment within LL6.

5.6.4. AEOLIX Acceptance and Trust at LL6

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following Figure 105 shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis shows that AEOLIX acceptance and high trust level are utmost necessary for high level of service quality as perceived by users. Furthermore, AEOLIX acceptance and trust impacts 'to a greater extent' on the following aspects:

- Improvement in planning and overall performance
- Improvement in efficiency of operations
- Increased responsiveness
- Approval of AEOLIX technology by users
- Establishment of deeper relationship with users

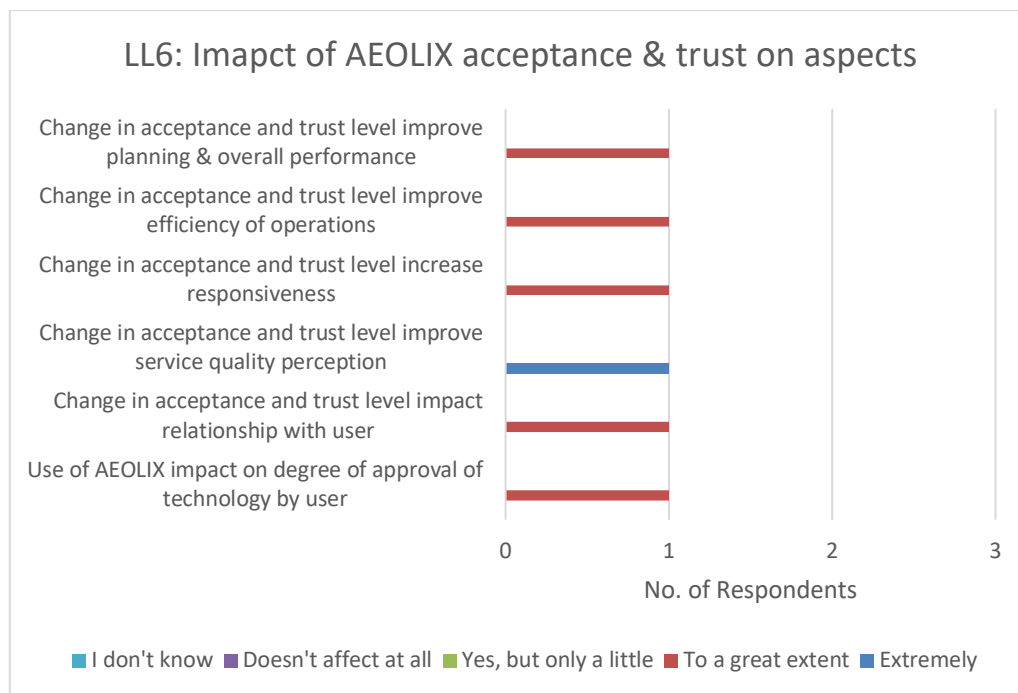


Figure 105: AEOLIX acceptance & trust impacts on various aspects at LL6

The study asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 106 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL6 evaluation manager.

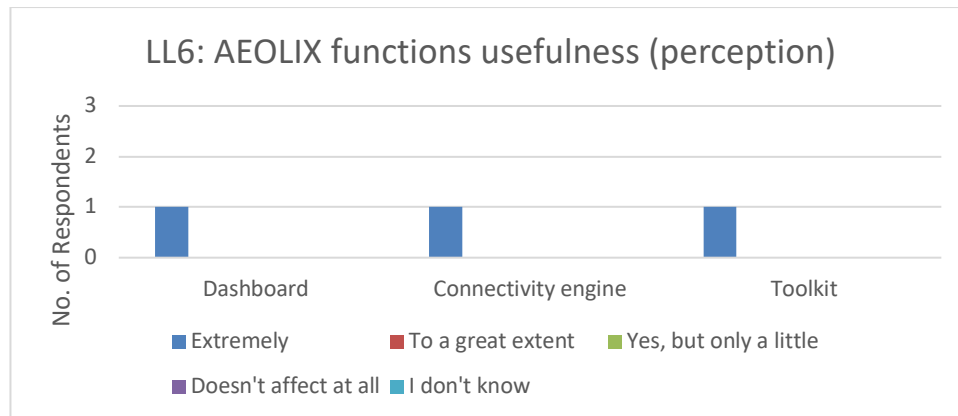


Figure 106: AEOLIX functions usefulness at LL6 (perception)

All three function, Dashboard, toolkit services and connectivity engines were considered to be 'extremely' useful at the beginning of AEOLIX.

Following Figure 107 shows the experiences after using AEOLIX. This clear that Dashboard that was considered to be extremely useful, does not have any significance impact on improving the business at LL6. In fact, LL6 is using its own Dashboard function. Only, connectivity engine met it expectation and proved to be useful to a great extent. Finally, toolkit services proved to be useful but only to a little extent for LL6 users. Based on these results, we can say that expect connectivity engine, none of AEOLIX function proved to as useful as anticipated in the beginning of the project.

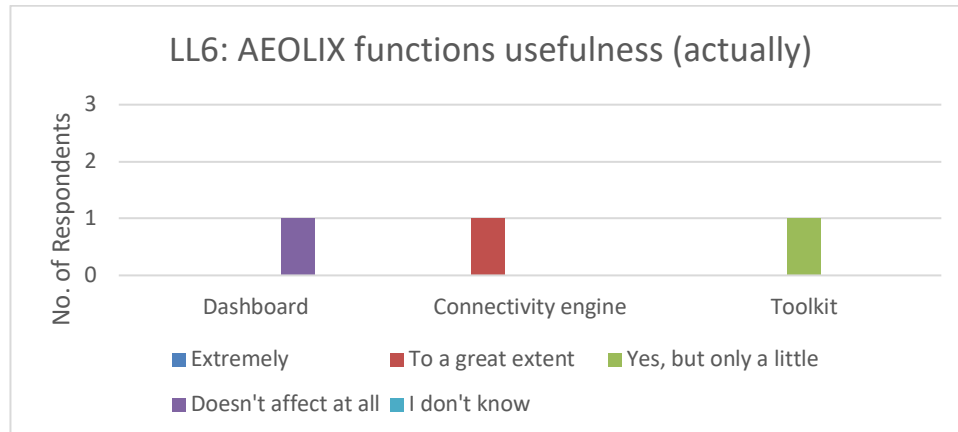


Figure 107: AEOLIX functions usefulness at LL6 (in actual)

Based on the above varied results, we can say that the acceptance and trust on AEOLIX is medium, since the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system.

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users shows interest 'To a great extent' on willingness to continue using connectivity engine only. However, LL6 did not find Dashboard to be very useful and using their own

customized Dashboard. Finally, LL6 found toolkit services extremely useful and extremely eager to continue using the AEOLIX function within their living lab. A summary is presented in Figure 108.

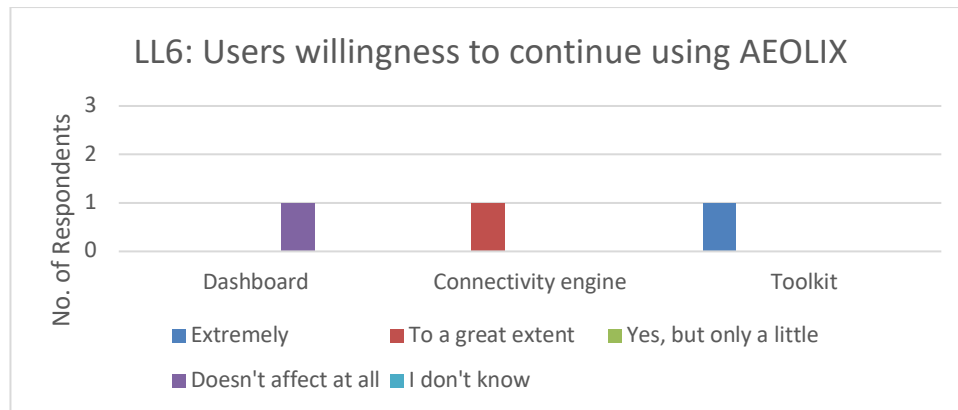


Figure 108: Users willingness to continue using AEOLIX at LL6

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results show that LL6 users trust varies across different function. Only the connectivity engine was able to win users trust 'to a great extent'. But they do not have much good experience or faith on the functionality and usefulness of AEOLIX Dashboard. Finally, toolkit services are useful but due to different implementation problems, the trust on this function can achieve on a low level.

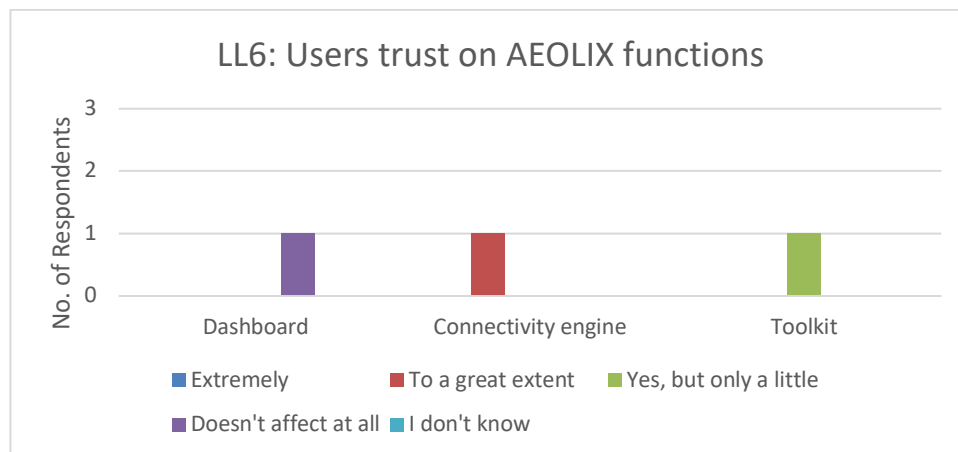


Figure 109: Users trust on AEOLIX functions at LL6

5.7. LL7 Operational Impacts Assessment

LL7, also known as FMCG lab, is looking into operations in Sweden, in Malmö and Stockholm areas, mainly. This living lab has COOP Logistik as one of the key players and involves in wholesale as well as retail trading activities. The living lab is focusing on improving information sharing within the COOP planning and operations in the terminal in Bro, the terminal in Malmö as well as the train operators. A short summary of the company (COOP) using the AEOLIX is provided in the Table 31 below:

Table 31: An overview of COOP within LL7

No. Of Employees	800
Role in Supply Chain	Retail and warehouse
Mode of Transport (Trucks / Rail / Vessels).....	Rail (semi-trailers)
<i>Owned by company</i>	90
<i>External partners owned</i>	2 Locos 50 railwagons for th Coop train
Areas of Distribution (Urban, Rural, National/Domestic, International)....	
<i>Urban , National</i>	Urban, Domestic
<i>Rural</i>	Rural, Domestic
Average Experience of Employees (duration)	More than 6 years
Types of group(s) of goods/products dealing with...	Food products, beverages and tobacco
<i>Type of Cargo -Road.....</i>	Palletized goods
<i>Type of Cargo - Sea Freight.....</i>	Containers

5.7.1. LL7 Business Aspects – Reduced Operational Costs

The business aspects of LL7 at operational level are mainly concerned with the reduced operational costs. Before we go on to the specific costs, we will provide summary of benefits within LL7 which are measured in terms of KPIs. These KPIs led to financial benefits in terms of reduced terminal operations costs, directly or indirectly. These KPIs include:

- Average loading and unloading time
- Terminal productivity
- Administrative work
- Modal shift
- Visibility / data sharing
- Financial benefits
- Terminal handling efficiency
- Acceptance and trust

After obtaining the list of KPIs, this study collected data on various KPIs. A summary of these values is presented in Table 32 below:

Table 32: Summary of KPIs benefits at LL7

Business impacts LL7	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Reduction in fuel consumption (l/km; km/l; or l/tkm)	20-25%	Not measured			AEOLIX has only been implemented in trains only, so far.
Increase in consolidated trips (#)	25-30%	Not measured			Trains are already fully consolidated
Decrease in % of empty runs	5-10%	Not measured			Not measured
Modal Shift (Road)		65	65	0	No impact on modal shift.
Modal Shift (Rail)		30	30	0	
Modal Shift (Vessel)		5	5	0	
Terminal handling efficiency					Only 3% of the total warehouse cost is affected

Reduction in Fuel Consumption

AEOLIX has only been implemented in trains so far which runs on electricity. Therefore, reduction in fuel consumption is not applicable at the moment. The system is under consideration to be implemented in trucks. Once the system will be installed in trucks, fuel consumption will be available.

Increase in Consolidated Trips

Trains run between Malmö and Stockholm in Sweden and already fully loaded.

Decrease of empty runs

Trains run between Malmö and Stockholm in Sweden and already fully loaded. Therefore, empty runs are not applicable. This will be applicable when the system will be implemented in trucks.

Modal Shift – Road, Rail and Vessels

COOP, within LL7, already has intermodal shift solution. There hasn't been any modal shift after AEOLIX. The modal shift for road is 65 before and after AEOLIX. The modal shift for rail stays at value 30 before and after AEOLIX. Finally, Vessels stays at value 5 before and after AEOLIX. This is shown in the Figure 110 below.

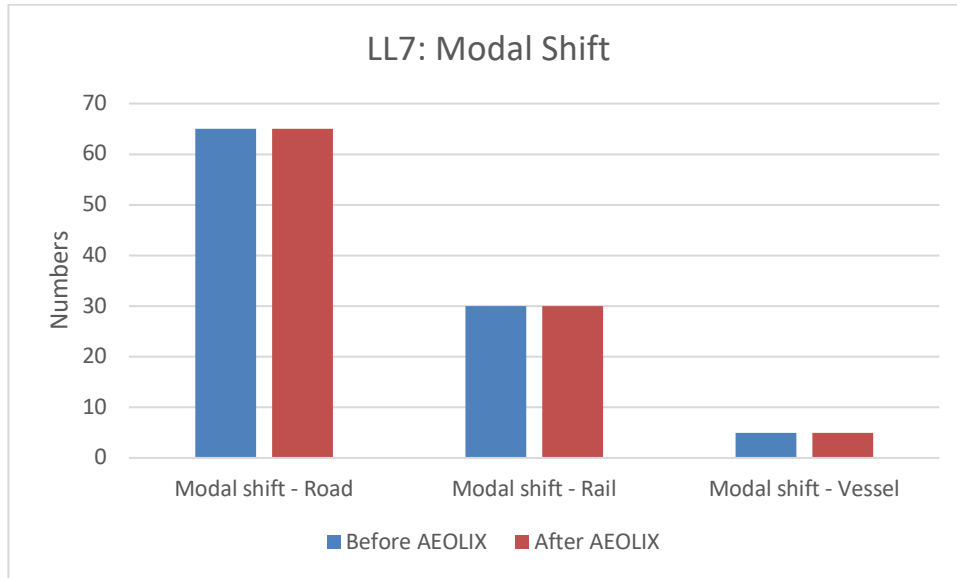


Figure 110: Modal shift at LL7 (before & after AEOLIX)

Reduction of Average Loading/Unloading Time

The use of AEOLIX has not affect loading/unloading time. The only savings occur in put-away time when forklift trucks travels between unloading dock and storage position. The following Figure 111 shows the reduction of average loading/unloading time which is 5% for COOP.

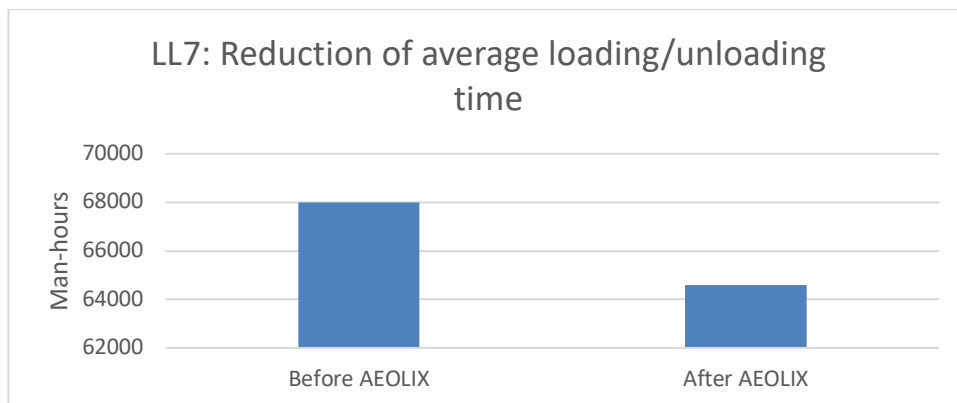


Figure 111: Average loading/unloading time at LL7 (before & after AEOLIX)

Increase of Terminal Productivity

80% of the warehouse cost is picking and replenishment, approximate 10% of the cost refers to inbound processes. 30% of inbound is done by intermodal trailers which means that only 3% of the total warehouse cost at COOP, Stockholm is affected. Therefore, unloading is only a small part of the warehouse operations. The main benefit is that information is available on one place for COOP. The values are presented in the Figure 112 below.

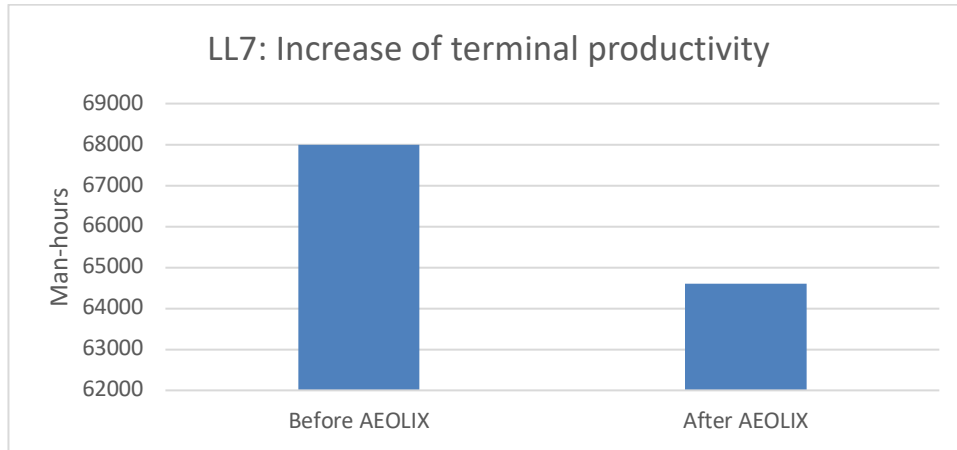


Figure 112: Terminal productivity at LL7 (before & after AEOLIX)

Costs Reduction for LL7

The only cost reduction relevant for LL7 is related to distribution center operations (reduction in facilities and labor) which has a target value of 3-5% (according to AEOLIX agreement). COOP has been able to reduce cost from 34 00 000 euros to 32 30 000 euros which is 5%. Therefore, we can say that LL7 has met its cost reduction target related to distribution center operations. This cost is measured for unloading trailers and put-away forklift trucks. The calculation is made on the basis of 50 euros per man-hour at COOP. Following Figure 113 shows the reduction values in euros:

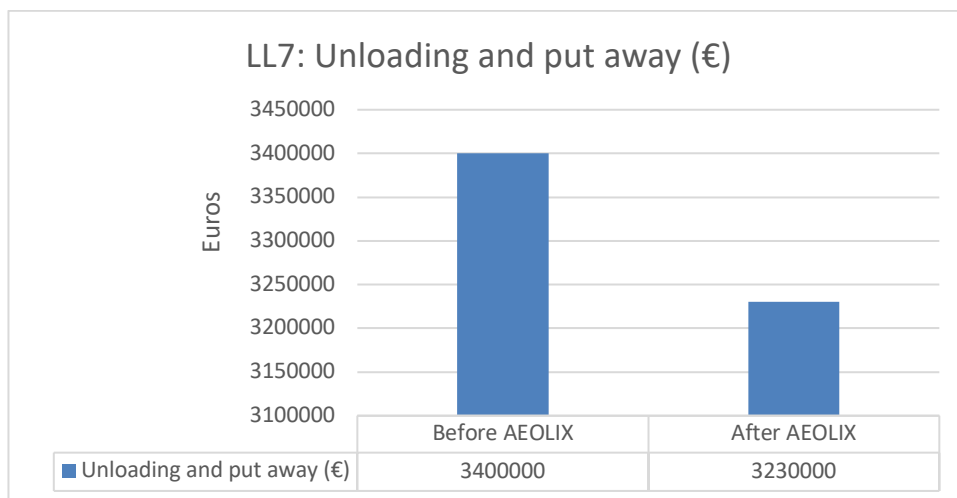


Figure 113: Unloading and put-away benefits at LL7 (before & after AEOLIX)

5.7.2. LL7 Environmental Aspects

Reduced CO₂ Emissions

The use of AEOLIX does not have any impact CO₂ emission with LL7. This is due to the reason that the system has been implement for trains only. These trains run on electricity, therefore CO₂ emission is

not applicable or relevant for LL7. The system is under consideration to be implement in trucks. Once the system will be installed in trucks, it will be possible to calculate CO₂ emission.

Reduced Noise Pollution

AEOLIX, in general, and Dashboard in particular has no effect on reducing noise pollution. This has been shown in Figure 114 below:

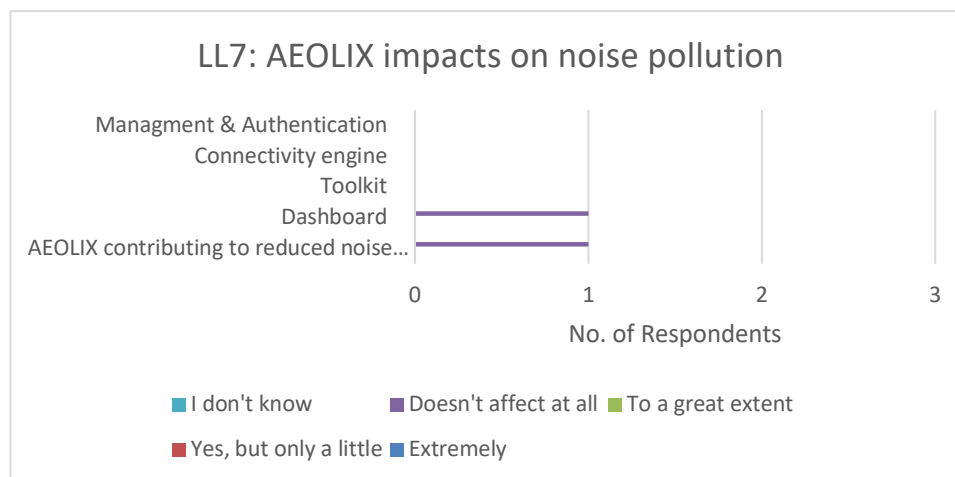


Figure 114: AEOLIX impact on reduced noise pollution at LL7

5.7.3. LL7 Socio-economic Aspects

The analysis of responses shows that AEOLIX has not clear impacts on socio-economic aspects within LL7. A summary of these results is presented the following sections:

Job Creation

First of all, job creation has not been influenced by the use of AEOLIX. In other words, we can say that AEOLIX has not led to any job creation or it is difficult to foresee the impacts of AEOLIX on job creation. This is mainly due to the reason that AEOLIX has recently been implemented with LL7. Since LL7 has moved from phone calls and regular excel sheets to dashboard, some expert jobs related to data analytics may be need in the future. Following Figure 115 shows that AEOLIX is not considered to have huge impacts on jobs related to drivers and operators within LL7.

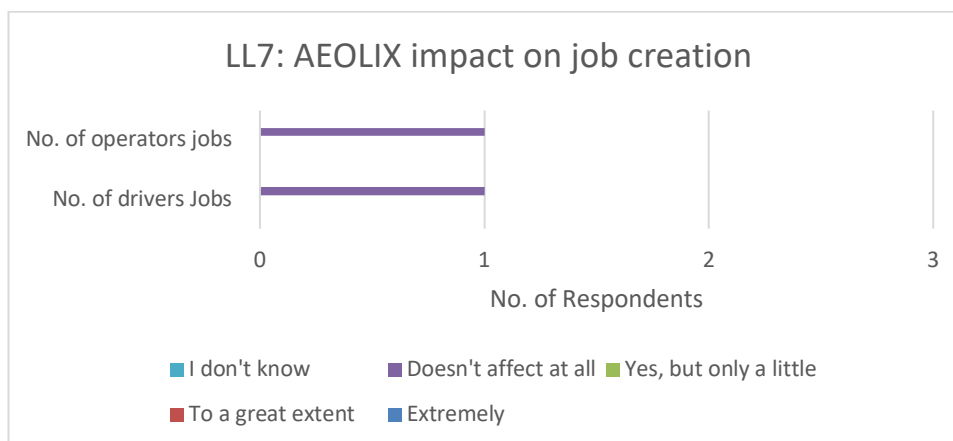


Figure 115: AEOLIX impact on job creation at LL7

SMEs Empowerment

SMEs empowerment has been considered as a main aspect of socio-economic impacts of AEOLIX. However, due to late implementation of AEOLIX and absence of AEOLIX implementation in SMEs within living lab 7 results in unknowing of its impacts socio-economic aspects – increase in market share and increased collaboration with large companies. One thing to remember here is that AEOLIX has been implemented in COOP logistics which already is a large organization with over 800 employees. Following Figure 116 shows AEOLIX impacts on SMEs empowerment:

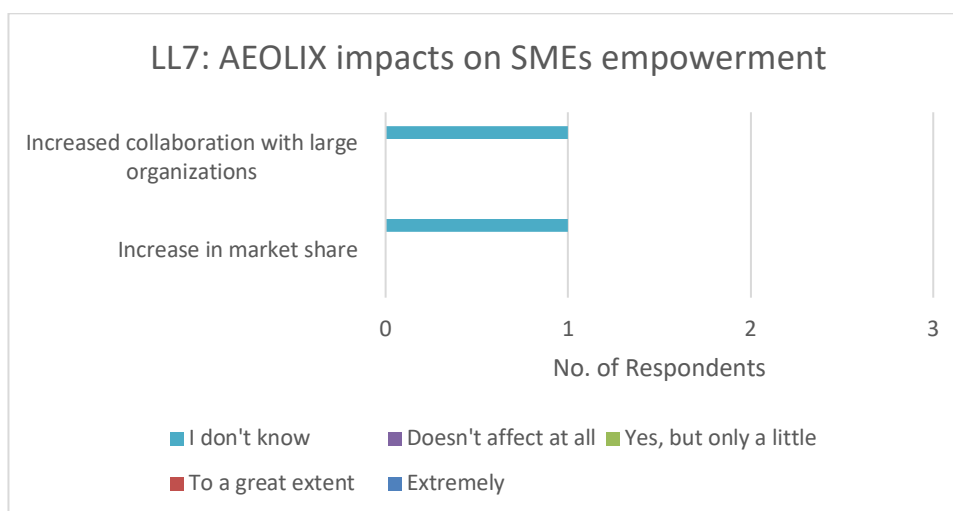


Figure 116: AEOLIX impact on SMEs empowerment at LL7

Improved Quality of Life

Like job creation and SMEs empowerments, the impacts of AEOLIX on improved quality of life are either unknown or does not have any impacts. The reasons are the same as mentioned in the previous sections. Figure 117 below shows results of responses related to improved quality of life within LL7:

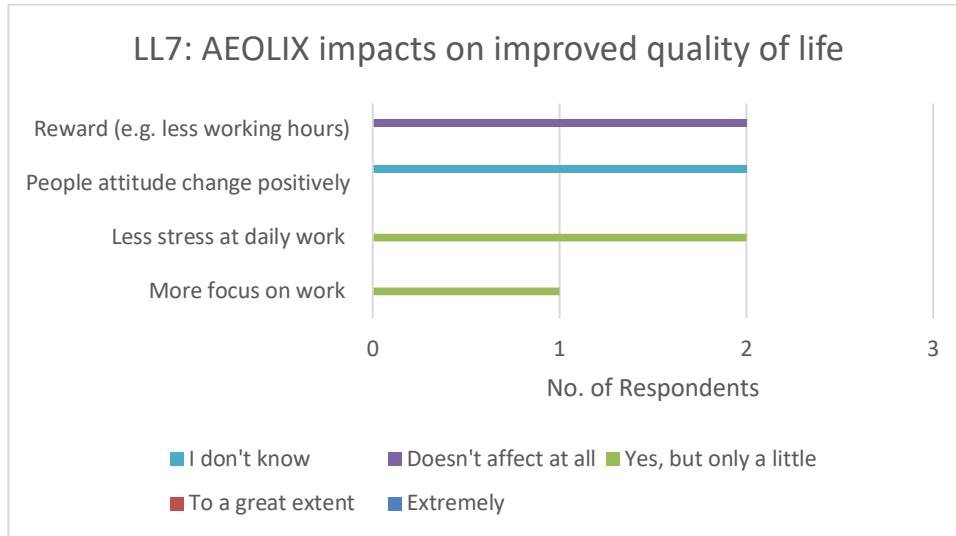


Figure 117: AEOLIX impact on improved quality of life at LL7

The use of AEOLIX has helped employees to put more focus on work, but only to a little extent. Similarly, employees feel less stressful 'but only a little' with the use of AEOLIX. For the aspect people attitude changing positively towards blue collar jobs is not known yet. Last but not the least, the results show that AEOLIX has not rewarded employees (for example, by reducing number of working hours). Rather the time saved with AEOLIX, for example, is treated as a saving or efficiency for businesses by the managers.

5.7.4. AEOLIX Acceptance and Trust at LL7

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis show that LL7 evaluation manager thinks that AEOLIX use is directly related to the improvement in perception of service quality 'to a great' extent. On the other hand, acceptance and trust on AEOLIX 'doesn't affect at all' on increase responsiveness.

For rest of the aspects, AEOLIX acceptance and trust still plays important role but only a little. For example, acceptance and trust on AEOLIX has 'only a little' impact on improvement in planning and overall performance, Improving efficiency of operations, relationship with users and overall degree of approval of AEOLIX by users. This is shown in Figure 118 below:

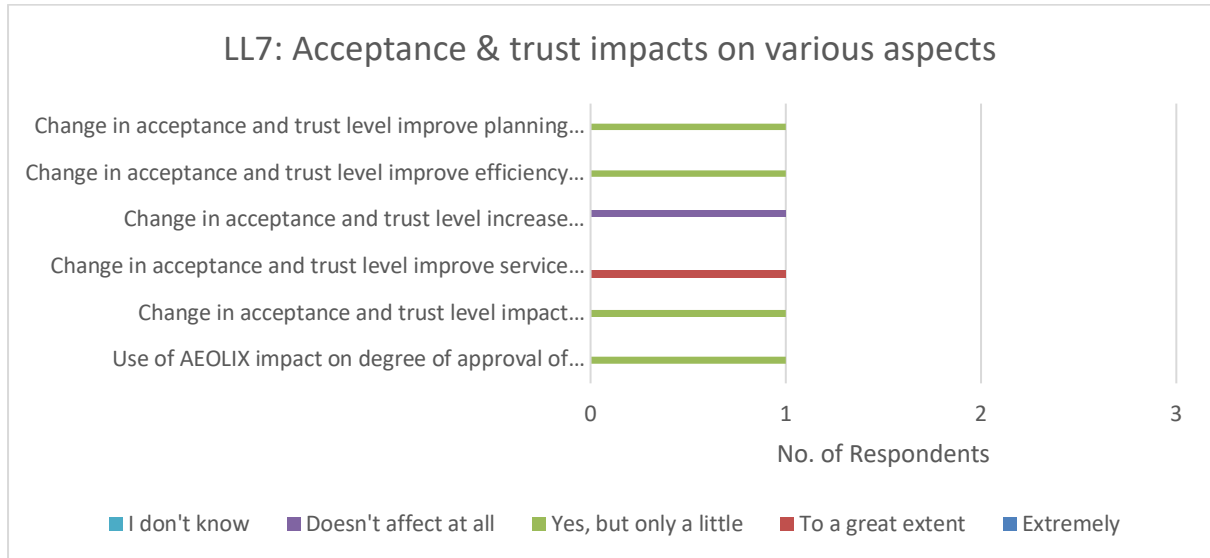


Figure 118: AEOLIX acceptance & trust impacts on various aspects at LL7

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 119 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL7 evaluation manager.

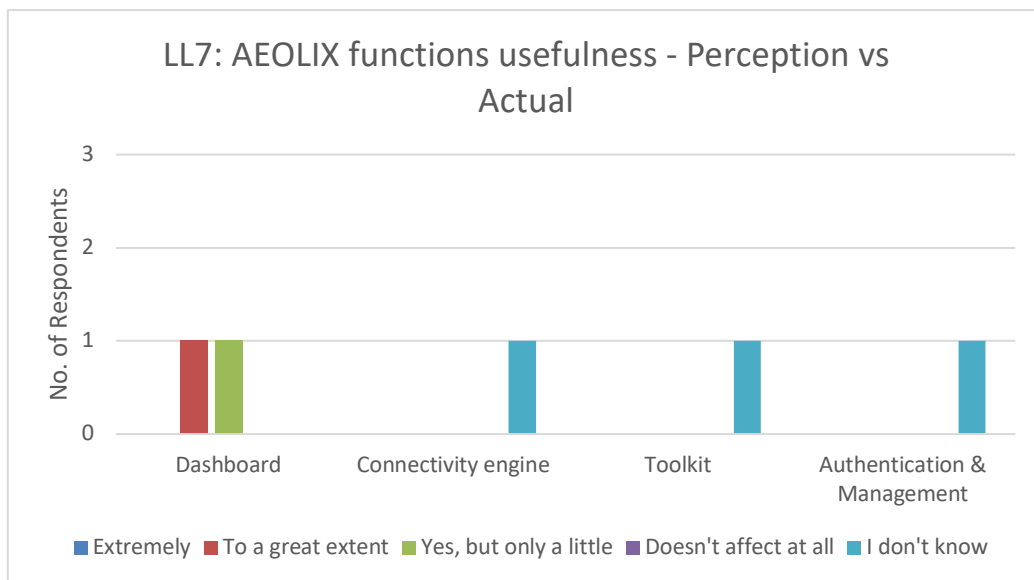


Figure 119: AEOLIX functions usefulness at LL7 (perception vs actual)

Dashboard was perceived to be useful 'to a great extent'. However, it turned out to be useful but 'only a little' at this early stage of deployment. The usefulness for the rest of the AEOLIX functions is not known by LL7 participant. manager.

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users shows interest ‘To a great extent’ on willingness to continue using Dashboard. For the rest of AEOLIX functions, their intention is unknown or uninterested as shown in Figure 120 below:

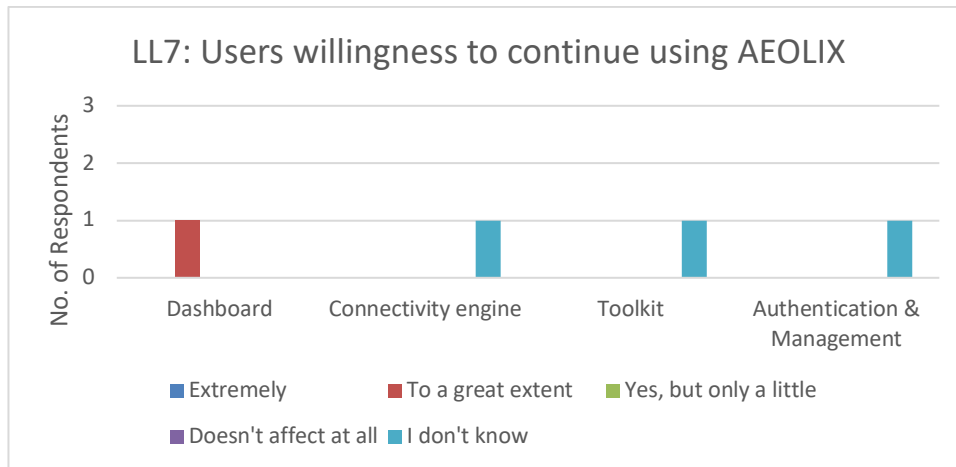


Figure 120: Users willingness to continue using AEOLIX at LL7

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results show that users trust, but only a little on dashboard. Dashboard has proven to be useful to a little extent and this may be the reason for low trust on Dashboard function. Following Figure 121 shows the results:

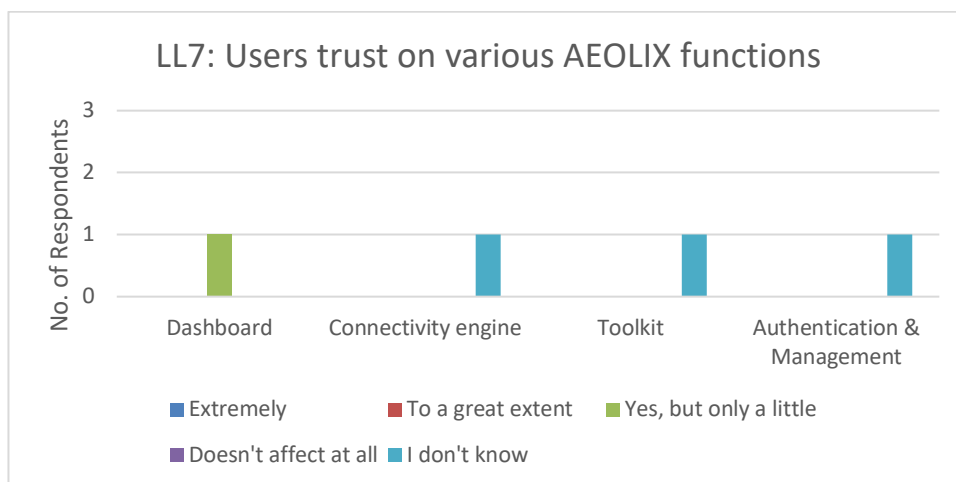


Figure 121: Users trust on AEOLIX functions at LL7

One of the reasons of low trust level is the little use of AEOLIX system which is less than 40 hours per month for LL7. The reason for little use is also associated with late development and implementation of the complete AEOLIX system.

Another important aspect for AEOLIX acceptance and trust is ‘ease of learning’. We ask the questions ***To what extent, users perceive that AEOLIX will be easy to learn? And to what extent AEOLIX actually proved to be easy to learn?***

Following Figure 122 shows the results on ease of learning for LL7:

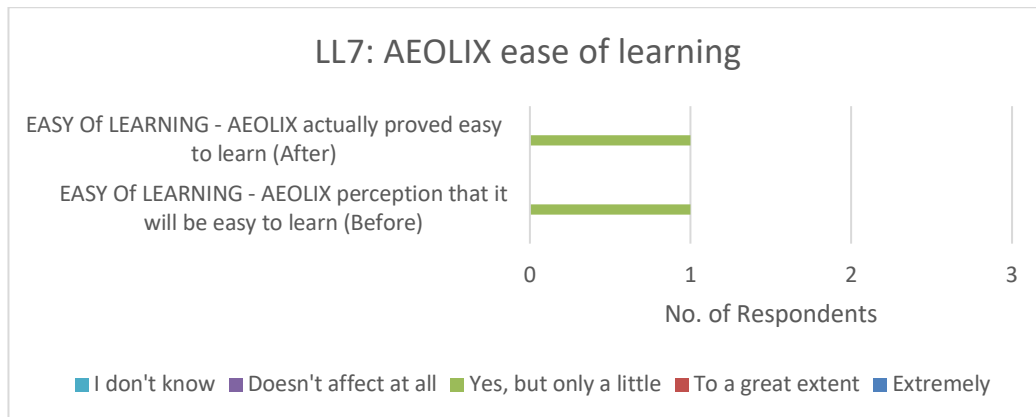


Figure 122: AEOLIX ease of learning (perception vs actual)

LL7 participants seems to be pragmatic when it comes to learning new technologies. They already perceived that learning AEOLIX will be easy 'but only a little'. In other words, they knew that they have to put efforts in learning the new system. This may be because of the fact that LL7 did not had any system in place before. This difficulty in 'ease of learning' effects AEOLIX acceptance and trust, negatively.

This study further asked about examples on easy of learning. An example is 'AEOLIX Dashboard effects on daily tasks perception'. The perception before AEOLIX was that uploading of train loading plan should work automatically. However, LL7 users face some difficulties as unloading train loading plan did not work sometimes.

This study further investigated number of aspects related to AEOLIX acceptance. The results are presented in Figure 123below:

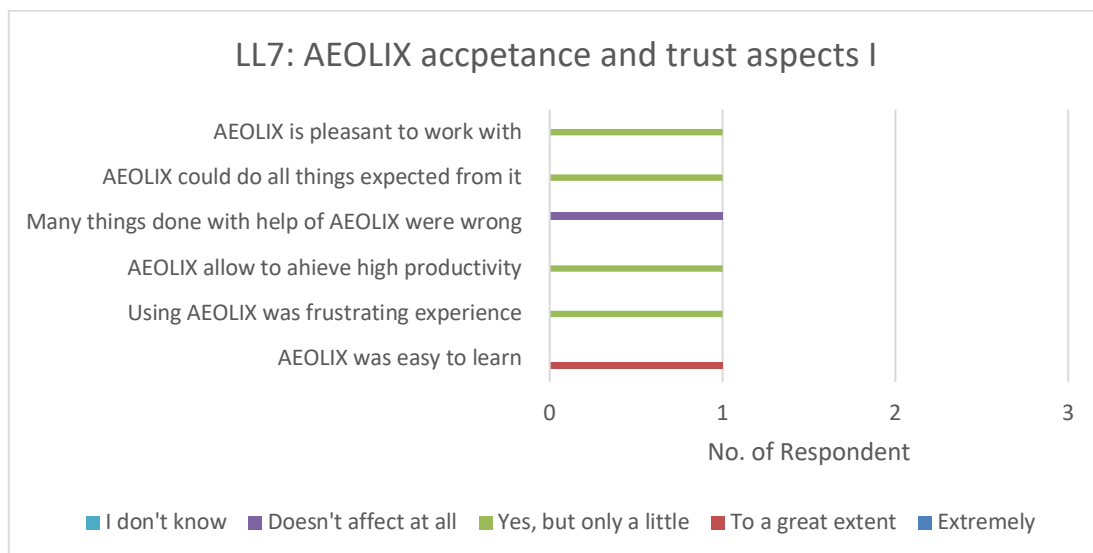


Figure 123: AEOLIX acceptance & trust impacts on various aspects at LL7

This is clear from the results that only learning AEOLIX was experienced as easy 'To a great extent' While many activities at LL7 that were conducted with the help of AEOLIX did not proved to be wrong. This is directly related to the usefulness of AEOLIX. For rest of the aspects including frustrating experiences, high productivity, not fulfilling its intention, and pleasant to work with AEOLIX have been appreciated 'to a little extent' within LL7.

Last but not the least, we probed into further aspects related to AEOLIX acceptance and trust as shown in the Figure 124 below:

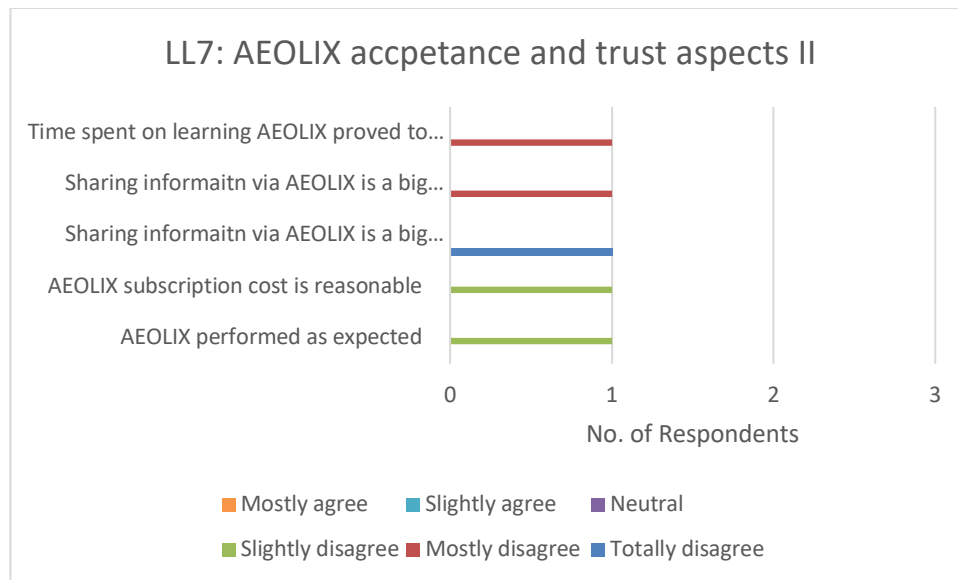


Figure 124: AEOLIX acceptance and trust aspects-I at LL7

The analysis of the results shows that LL7 respondent thinks that sharing information via AEOLIX is not a big hurdle in adopting the AEOLIX system. This may be due to the fact that COOP manager is used to technology and information sharing via technology systems in daily life. Therefore, seeing information sharing via AEOLIX is not seem as a big concern at COOP. However, the time spent on AEOLIX doesn't proved to be very useful due to unknown reasons. Furthermore, subscription cost is not known yet to LL7 as most of the cost is being covered by the project. Last but not the least, LL7 have higher expectations on AEOLIX in term of the performance.

5.8. LL8 Operational Impacts Assessment

LL8 of Unilever belongs to supply chain visibility group of living labs. Important stakeholders in this living lab include Unilever and University of Northampton.

LL8 supports the role of shipper or manufacturer in the supply chain. The major mode of transport includes hundreds of trucks which are owned by external partners. The living lab serves in both urban and rural areas within the domestic and international areas. Main types of goods or products which LL8 include food products, beverages and tobacco. The main cargo on road include palletized goods and liquid bulk goods, and cargo on sea freight include containers for LL8. LL8 claimed to measure number of KPIs including:

- Average fuel consumption
- Average number of trips with consolidated cargo
- Average waiting time
- Average loading/unloading time
- Terminal productivity
- % of load factor
- Administration work
- Traffic avoidance / congestion reduction
- Visibility / data sharing
- Interoperability
- Financial benefits
- Dynamic reconfiguration of shipments
- Acceptance and trust

After the list of KPIs, we explored how various KPIs contributed to different services at LL8.

KPIs and services at LL8

After the benefits of various KPIs within LL8, we explored how various KPIs are contributing to different services at the living lab. A short description of this relation between KPIs and services is presented in the following paragraphs.

Alert Relevant Parties as to Product Availability

Primary function, informs the relevant parties of the supply chain of alterations to production plan, truck procurement such that scheduling can be altered to account for this. The following Table 33 shows list of KPIs and how they related to alert relevant parties as to product availability:

Table 33: KPIs impacting alert about product availability at LL8

KPIs	Description of KPIs (i.e. how specific KPIs contributed to alert relevant parties as to product availability)
KPI_7: % of load factor	Product Availability includes num pallets to ship, alongside truck capacity provide means to calculate load factor for each shipment

KPI_9: Administration work	Vary pre/post AEOLIX. Currently a team dedicated to these means, post AEOLIX alleviates this necessity and places logging responsibilities on on-floor operators. 2 Separate measures.
KPI_14: Visibility / data sharing	Logging on reception of delivery whether it was on time/full or both.
KPI_15: Interoperability	Similar to KPI_9, two measures of the two alternate approaches. If AEOLIX achieves on-floor integration, latency should fall to near-0 levels compared to current manual information transmission
KPI_16: Financial benefits	Time reduction in logging, solution alerts availability of shipment. Vehicle, in theory reducing idle-time fees, solution can provide means to identify potential consolidations
KPI_20: Standardization	Provides means for automated reporting, determine number of manual reports still required, compare to total that have been automated.

Report and Record Accurate Scheduling Information

One of the benefits of AEOLIX is to record estimated as well as actual times of departure and arrival. The following Table 34 shows list of KPIs and how they contribute to report and record accurate scheduling information:

Table 34: KPIs impacting reporting and recording scheduling information at LL8

KPIs	Description of KPIs (i.e. how specific KPIs contributed to report and record accurate scheduling information)
KPI_1: Reduction in average fuel consumption	Actual time of departure & arrival provide time travelling, alongside avg consumption measures provide means to calculate fuel consumption per trip.
KPI_4: Average waiting time	Average waiting time factors into arrival/departure at a particular site in tandem with loading time.
KPI_5: Average loading/unloading time	Average loading time factors into arrival/departure times at a particular site
KPI_6: Terminal productivity	Departure and Arrival times from each site further provide means to ascertain gate throughputs of each site.

After obtaining the list of KPIs, this study collected data on various KPIs. A summary of the results is presented in the following paragraphs:

Reduction in Fuel Consumption

LL8 did not provide value on reduction in fuel consumption. The only benefit it can get from AEOLIX is that there is less engine idling time due to less waiting time.

Increase in Consolidated Trips

LL8 has not been affected directly on consolidated cargo.



Average Waiting Time

Some 6% of shipments incurred waiting time charges; alerting carriers to changes in shipment availability should reduce this. The initial estimate may be that this can be reduced by 50%.

Average loading/unloading Time

Not (yet) measured, but with better shipment availability information, and better rescheduling, less uncertainty about loading dock and time, faster operation may result.

Terminal Productivity

Translating this to a factory location: see above regarding waiting time and (not asked) cancellation costs, as some 12% of shipments subject to rescheduling or delay; this may be reduced by some 50% using AEOLIX Dashboard.

% of load factor

LL8 has not been affected directly on % of load factor.

Administration work

Some of the benefits on administration work include the following:

- Changes are uploaded and all parties affected notified immediately
- Waiting time and cancelation charges can be reduced, by faster process
- Avoids repetitive sending of emails
- Higher accuracy of transport dispatch

Interoperability

Emails and phone calls and disparate data sources are replaced with automated alerts to multiple stakeholders, with data from multiple workflows being combined. Some of the benefits include:

- Workflow across multiple systems enabled
- Staff can be rapidly informed, and assets can be redeployed, trucks can be cancelled
- Overall product delivery streamlined across plant, carrier and warehouse
- Direct costs reduced with reduced truck waiting time

Standardization

Automated reporting removes responsibility of a particular individual. Some of the benefits include:

- Reduced risk of errors in alert emails on changes in plans avoiding human errors
- Reduced repetitive typing in of plan changes
- Accelerated work flow and efficiency in serving national markets
- Plant can be more responsive to changes in demand
- Overall process more streamlined and direct costs reduced

- Planning more efficient and responsive

5.8.1. LL8 Business Aspects - *Reduced Operational Costs*

The only cost type which LL8 has saved is related to logistics management (through trade management) which has a target of 5.5-6%. LL8 was able to reduce cost of truck waiting and cancellations by 50%. This is because of the reason that changes in production plans trigger delays and changes in shipment availability that can be relayed to carriers faster than without AEOLIX. This benefit related to logistics management is associated with planning rescheduling where the time has been reduced from 2 hours to 20 minutes. Here, Dashboard can process and communicated changes to multiple stakeholders automatically and instantly. An overview is presented in Figure 125

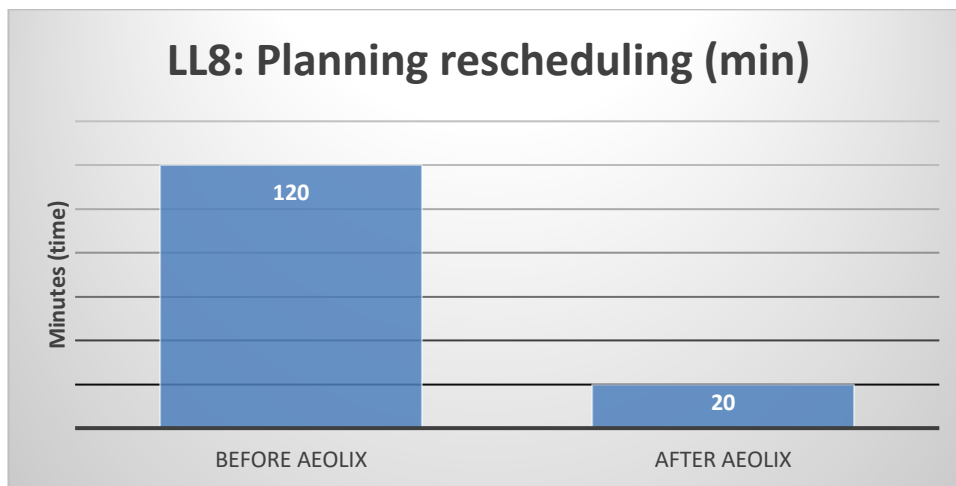


Figure 125: Planning and rescheduling benefits at LL8 (before & after AEOLIX)

This has affected shipment pickup activities. In terms of monetary value, this saves 15000 euros that are spent on waiting and cancellation.

The following Table 35 summarizes how different KPIs are related to or contribute to business aspects related to reduced operational cost.

Table 35: KPIs contributing to reduced operational cost at LL8

KPIs	Befor AEOLIX
Average waiting time	Less waiting time if trip cancelled on time
Average loading/unloading time	If trip rescheduled, to right loading door, faster loading
Terminal productivity	Higher productivity, lower cost
% of load factor	Higher load factor, more efficient trips, less cost

Visibility / data sharing	Downstream actors carriers and warehouse can see latest status, reallocate resources
Interoperability	Multiple actors at planning, at plant, at carrier, warehouse and marketing have access and see, edit data in dynamic as well as manual mode
Financial benefits	Financial benefits mean savings due reduced waiting time, better reallocation of all resources also at warehouse
Standardization	Reduced risk of errors in alerts that are sending emails on changes in plans using existing data sets, avoiding human errors

5.8.2. Environmental Aspects at LL8

Environmental aspects include reduced CO₂ emissions and reduced noise pollution.

Reduced CO₂ Emissions

No numerical value is available on reduced CO₂ emission for LL8. However, the following applies:

- Average fuel consumption: more fuel means more CO₂ emission
- Average waiting time: Less waiting time, usually less engine idling time
- Terminal productivity: Higher productivity, same job, less time, less CO₂

Reduced Noise Pollution

AEOLIX and Dashboard impact on reduction of noise pollution 'to a great extent'. While there is no information about impacts of other AEOLIX functions on reducing noise pollution. This is shown in Figure 126 below:

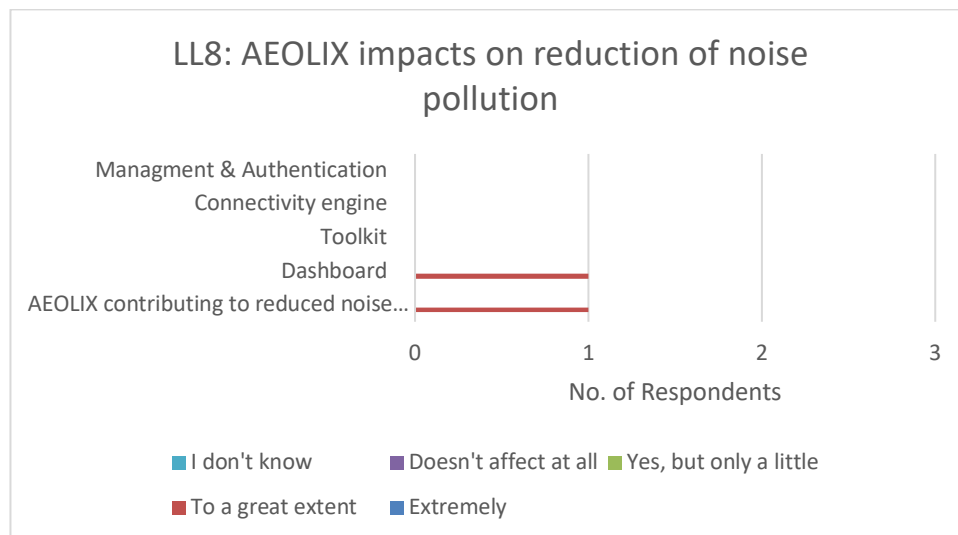


Figure 126: AEOLIX impact on reduced noise pollution at LL8

Like reduction in carbon footprints, different KPIs contribute to reduction in noise pollution as follows:

- Average waiting time: Less waiting time, usually less engine idling time
- Average loading/unloading time: Quicker (un)load, less consistent noise

- Terminal productivity: Higher productivity, lower cost

5.8.3. Socio-economic Aspects at LL8

Like other labs, socio-economic aspects for LL8 consist of job creation and SMEs empowerment. The following sections provides the summary of results.

Job Creation

Job creation has been considered as an important aspect where AEOLIX could affect. However, it seems that LL8 remained unaffected about job creation at the operational level for drivers and operators' jobs. This is due to the fact that it is difficult to anticipate the impacts of AEOLIX on job creation at this stage within LL8. A summary of AEOLIX impacts on job creation is presented in Figure 127 below:

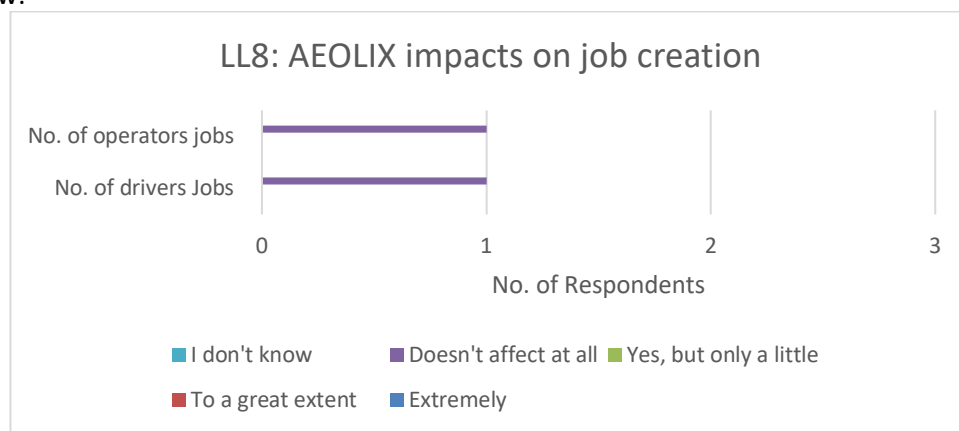


Figure 127: AEOLIX impact on job creation

SMEs Empowerment

Similarly, SMEs empowerment seems to have no impacts by AEOLIX. This may be due to the fact that Unilever where the AEOLIX system has been implemented is an example of a large organization. Yet, this company cannot see things from SMEs empowerment perspectives. Following Figure 128 shows the results of AEOLIX impacts on SMEs empowerment in terms of increase in market share and increased collaboration with large organizations.

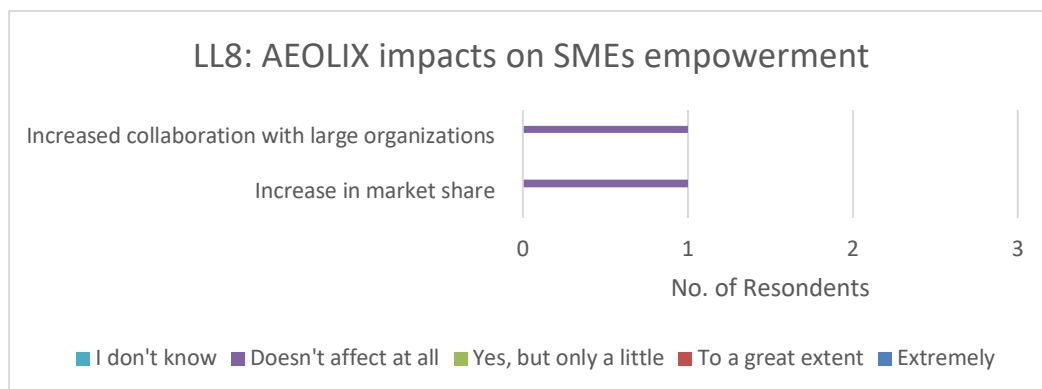


Figure 128: AEOLIX impact on SMEs empowerment at LL8

Improved Quality of Life

Last but not the least of socio-economic aspects is improved quality of life for employees at work. AEOLIX seems to be especially helpful in reducing stress at daily work ‘to a great extent’. While, AEOLIX also facilitated employees to put more focus on work ‘but only a little’. Since AEOLIX has not been implemented for a long time at LL8, therefore it is difficult to see any impacts on change in people attitude towards employees using AEOLIX or even a reward (e.g. less working hours) coming out of it. Following Figure 129 presents summary of results:

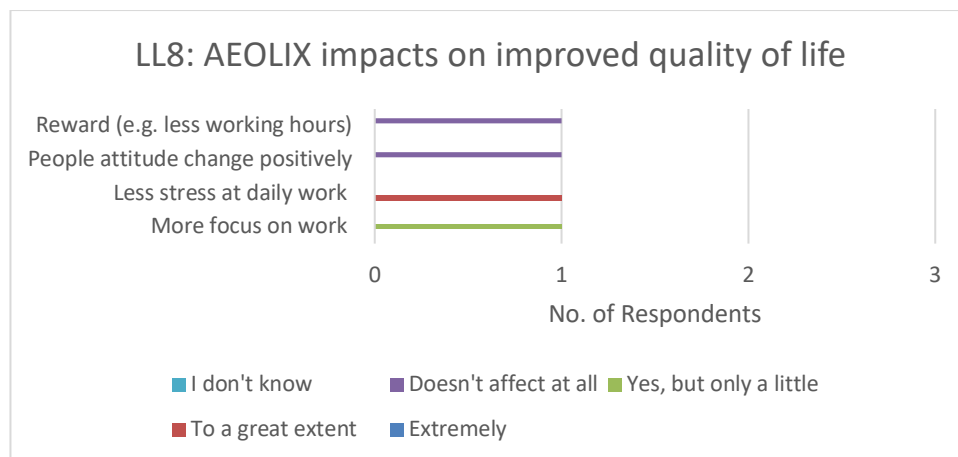


Figure 129: AEOLIX impact on improved quality of life at LL8

Like aforementioned two socio-economic sub-aspects, different KPIs contribute to the socio-economic aspect of improved quality of life for employees at work at LL8, and is as follows:

- Average waiting time: Less waiting, higher employee satisfaction
- Average loading/ unloading time: Quicker (un)load, more time elsewhere
- Visibility / data sharing: Easier to see information
- Interoperability: Quicker information exchange, quicker accessibility to said data
- Standardization: Automated reporting removes responsibility of particular individual
- Acceptance and Trust: Accepting solution implies benefits can be ascertained from its usage

5.8.4. Acceptance and Trust of AEOLIX at LL8

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures show how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. This study has explored the impact of AEOLIX acceptance and trust on number of various aspects. The response by living lab evaluation manager provides data only on degree of approval of AEOLIX by users ‘but only a little’ within LL8. No responses were provided for other aspects.

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following figure shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL8 evaluation manager. Only dashboard is considered to be useful 'to a great extent'. No information is available for the rest of the functions. Following Figure 130 shows results of response:

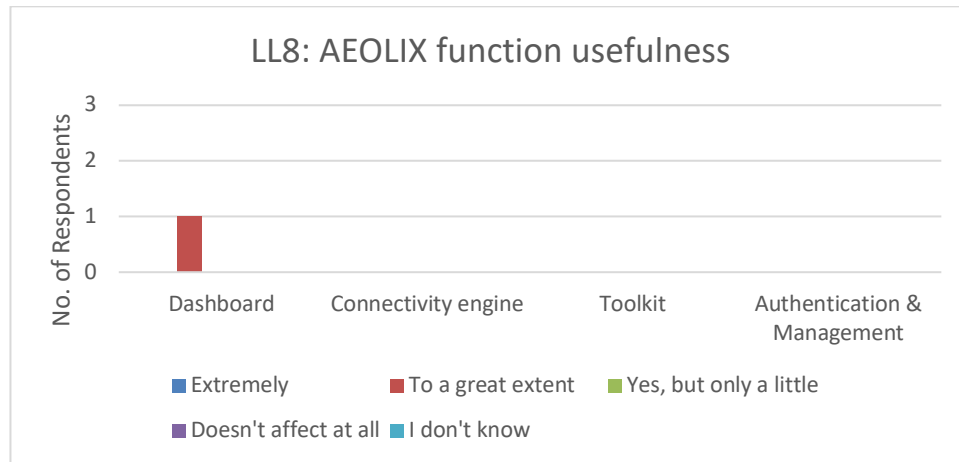


Figure 130: AEOLIX functions usefulness at LL8 (in actual)

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users shows interest 'To a great extent' on willingness to continue using Dashboard. For the rest of AEOLIX, their intention is unknown or uninterested. This is shown in Figure 131 below:

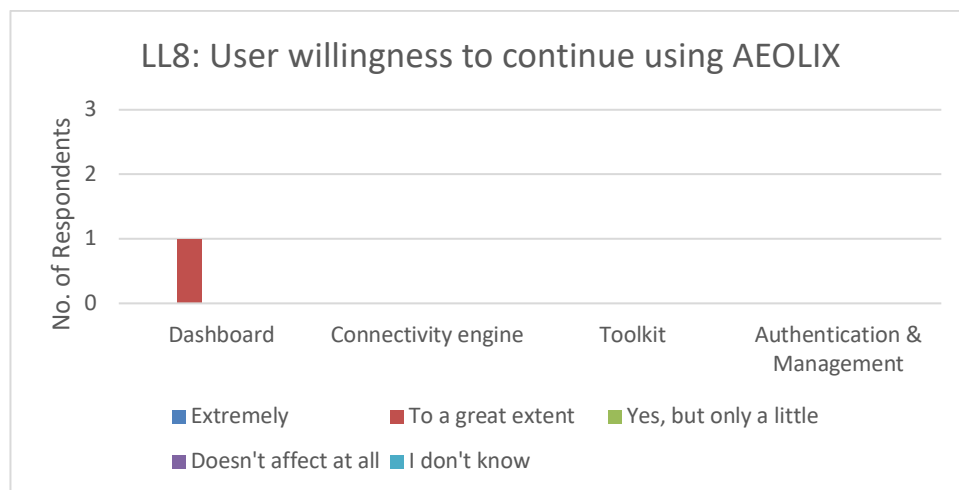


Figure 131: Users willingness to continue using AEOLIX at LL8

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results show that LL8 evaluation manager trusts 'to a great extent' on dashboard. Dashboard has proven to be useful to a great extent and this may be the reason for high trust on Dashboard function. Following Figure 132 shows the results:

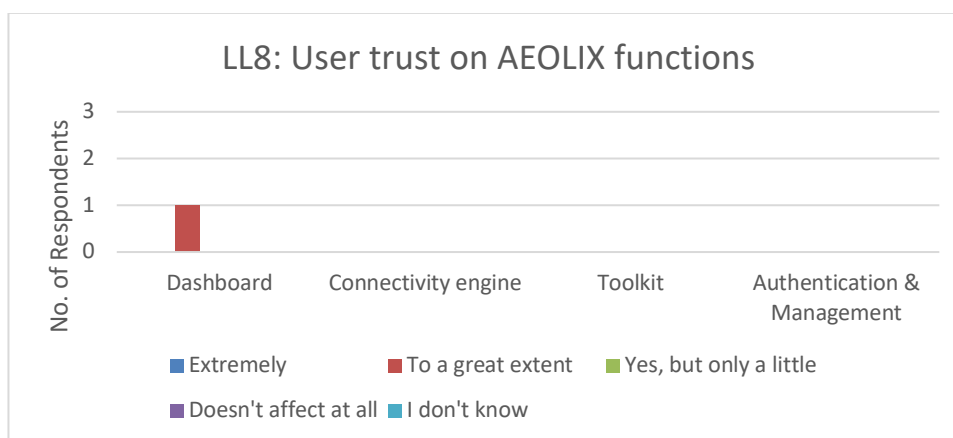


Figure 132: Users trust on AEOLIX functions at LL8

Another important aspect for AEOLIX acceptance and trust is 'ease of learning'. We ask the questions ***To what extent, users perceive that AEOLIX will be easy to learn? And to what extent AEOLIX actually proved to be easy to learn?***

Following Figure 133 shows the results on ease of learning for LL8:

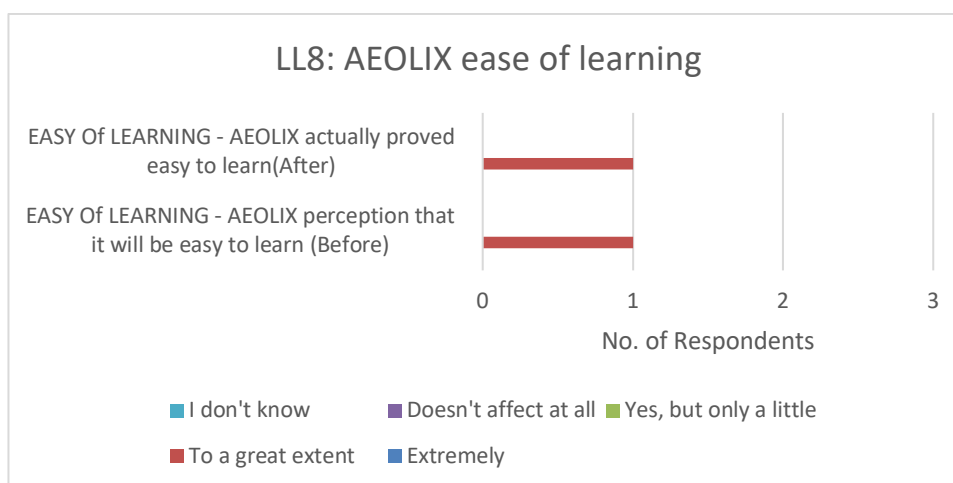


Figure 133: AEOLIX ease of learning at LL8 (before & after AEOLIX)

LL8 participants seems to be pragmatic when it comes to learning new technologies. They already perceived that learning AEOLIX will be easy 'to a great extent'. In other words, they knew that they have to put little efforts in learning the new system. This 'ease of learning' may result in high acceptance and trust on AEOLIX the living lab.

We further investigated number of aspects related to AEOLIX acceptance. For this we asked question: ***After using AEOLIX, to what extent do you agree with the following statements?***

The results are presented in the Figure 134 below:

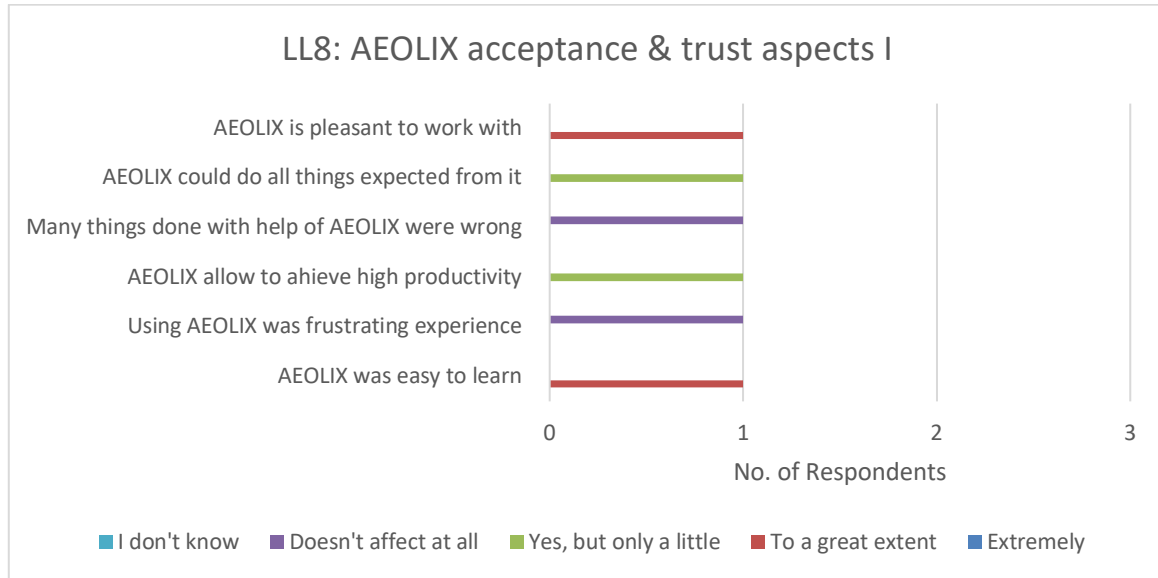


Figure 134: AEOLIX acceptance & trust aspects-I at LL8

This is clear from the results that only learning AEOLIX was experienced as easy 'To a great extent'. This was also a pleasant experience to work with AEOLIX 'to a great extent'. However, AEOLIX could do all things expected from it and to achieve high productivity 'to a little extent' only. On the other hand, the use of AEOLIX does not proved to frustrating experience or many things done with the help of it were useful.

Last but not the least, this study probed into further aspects related to AEOLIX acceptance and trust as shown in the Figure 135 below:

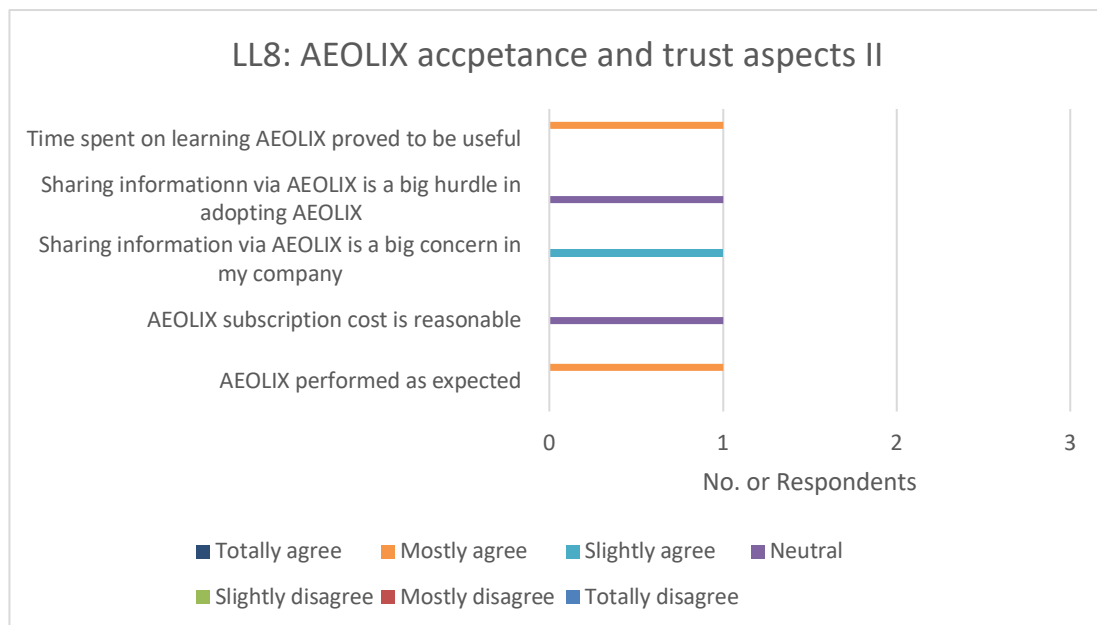


Figure 135: AEOLIX acceptance & trust aspects-II at LL8



The analysis of the results shows that LL8 respondent has neutral view on sharing information via AEOLIX as a hurdle and its subscription cost. The respondent 'mostly agree' that AEOLIX performed as expected and the time spent on learning AEOLIX proved to be useful. Last but not the least, sharing information via AEOLIX is a big concern in the company within LL8.

5.9. LL9 Operational Impacts Assessment

Living Lab 9 (LL9), with Jan de Rijk as the leading partner is an example of a network optimization living lab. The aim of the living lab is to enhance network efficiency and effectiveness and the use of cross-chain capacities to optimize employment of assets and services and realize reduction in overall logistic costs and externalities.

LL9 consists of number of companies and organizations. However, we got responses from only one manager from Jan de Rijk. The company has a role of hub or terminal operator and vessels owners in the supply chain. Furthermore, the company operates two rail services and 700 trucks for the distribution of goods to carry out logistics activities. In this regard, the company serves both rural and urban areas on domestic as well as international levels. The average experience of employees at the company is more than six years. In addition, the company is involved in the transportation of the following goods or products:

- Products of agriculture, hunting, and forestry; fish and other fishing products
- Food products, beverages and tobacco
- Textile and textile products; leather and leather products
- Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media
- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
- Other non-metallic mineral products
- Basic metals; fabricated metal products, except machinery and equipment
- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
- Transport equipment
- Furniture; other manufacturing goods n.e.c.
- Secondary raw material; municipal wastes and other wastes
- Equipment and material utilized in the transport of goods
- Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods n.e.c.
- Grouped goods: a mixture of types of goods which are transported together

In order to deliver the above mentioned products, company uses the following mode of road cargo:

- Solid bulk goods
- Large freight containers
- Other freight containers
- Palletized goods

In the first step, we collected the list of KPIs measured by or relevant for LL9. This was done by asking LL evaluation managers in the beginning of this deliverable and re-confirmed during the assessment phase. KPIs measured by LL9 include the followings:

- Administration work
- Visibility / data sharing
- Interoperability
- Financial benefits
- Dynamic reconfiguration of shipments
- Standardization
- Acceptance and trust

KPIs and services at LL9

After selecting KPIs within LL9, we explored how various KPIs are contributing to different services at the living lab. A short description of this relation between KPIs and services is presented in the following paragraphs.

Alert Relevant Parties as to Shipment/Container

Primary function under this service is to inform the relevant parties of the supply chain of alterations to truck ETA and train Status, such that scheduling can be altered to account for this. The following Table 36 shows list of KPIs and how they related to alert relevant parties as to product availability:

Table 36: KPIs contributing to alert services at LL9

KPIs	Description of KPIs (i.e. how specific KPIs contributed to alert relevant parties as to shipment/container)
KPI_9: Administration work	local inspection of current time used
KPI_14: Visibility / data sharing	Number of schedule changes
KPI_15: Interoperability	Number of messages that can be exchanged
KPI_17: Dynamic reconfiguration of shipments	Number of cancellations at origin
KPI_20: Standardization	Provides means for automated reporting, determine number of manual reports still required, compare to total that have been automated.

5.9.1. LL9 Business Aspects - *Reduced Operational Costs*

LL9 is one of the examples where many KPIs are not applicable due to daily line haul service which is always fully booked. Therefore, it is really difficult to estimate the benefits of gained in LL9. No numbers of KPIs and financial benefits has been reported. Following Table 37 summarizes the responses received from LL9 evaluation manager.

Table 37: Summary of KPIs benefits at LL9 (before & after AEOLIX)

KPIs	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Increase in consolidated trips (#)	25-35%	DNA	DNA	DNA	The rail service is a daily line haul service and is always fully booked. Fuel reduction is not applicable
Decrease in % of empty runs	25-40%	Not measured			The rail service is a daily line haul service and is always fully booked. Consolidation of trips is not applicable
Increase of % of load factor (CBM or weight)	35-40%	Not measured			The rail service is a daily line haul service and is always fully booked. Increase in percentage of load factor is not applicable
Reduction in average CO ₂ emission		DNA	DNA	DNA	The rail service is a daily line haul service and is always fully booked. Reduction in average CO ₂ emission is not applicable
Administration work (minutes/hrs)		DNA	DNA	DNA	Reduced manual work; less repetition; faster data sharing
Visibility data sharing		DNA	DNA	DNA	Shared ETA and status across supply chain; allows reallocation of assets; number of calculations is small compared to total volume
Interoperability		DNA	DNA	DNA	Some 10 different status data can be shared more easily and non-automated data can be mobilized; overall better effectiveness
Dynamic reconfiguration of shipments		DNA	DNA	DNA	Small number of truck cancellations at departure and arrivals compared to total
Standardization		DNA	DNA	DNA	Some 10 different status data can be shared more easily and non-automated data can be mobilized; Data from TX on status can now be seen on Dashboard, without retyping; alerts are sent out automatically to report on delays and cancellation

The only business impact was reported benefits in terms of time (minutes) for data processing of container status. The time has been reduced per container from 5 minutes to 1 minute only per day. This equals to 80% reduction in time. However, total number of containers per day, week or month are not known. Following Figure 136 shows this reduction:

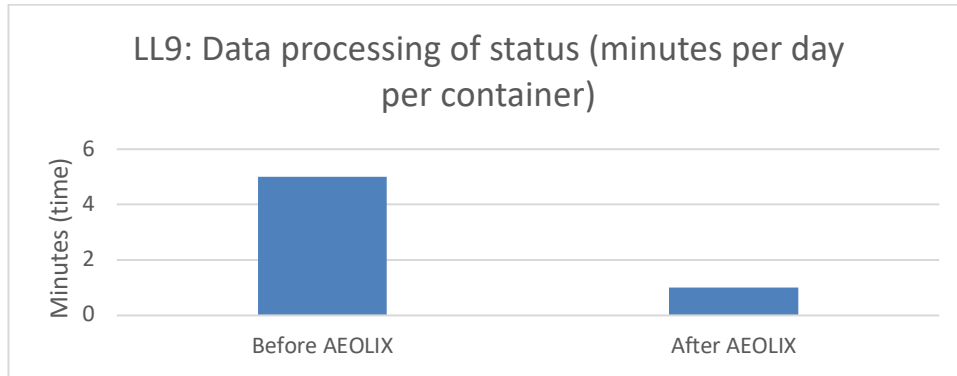


Figure 136: Data processing at LL9 (before & after AEOLIX)

However, this reduction in time is not seen as improvement at all because staff will still be needed for the data processing of container status.

5.9.2. LL9 Environmental Aspects

Environmental benefits include reduced CO₂ emission and noise pollution. The results are presented below.

Reduced CO₂ Emissions

The rail service is a daily line haul service and is always fully booked. Reduction in average CO₂ emission is not applicable.

Reduced Noise Pollution

Following Figure 137 shows the summary of responses:

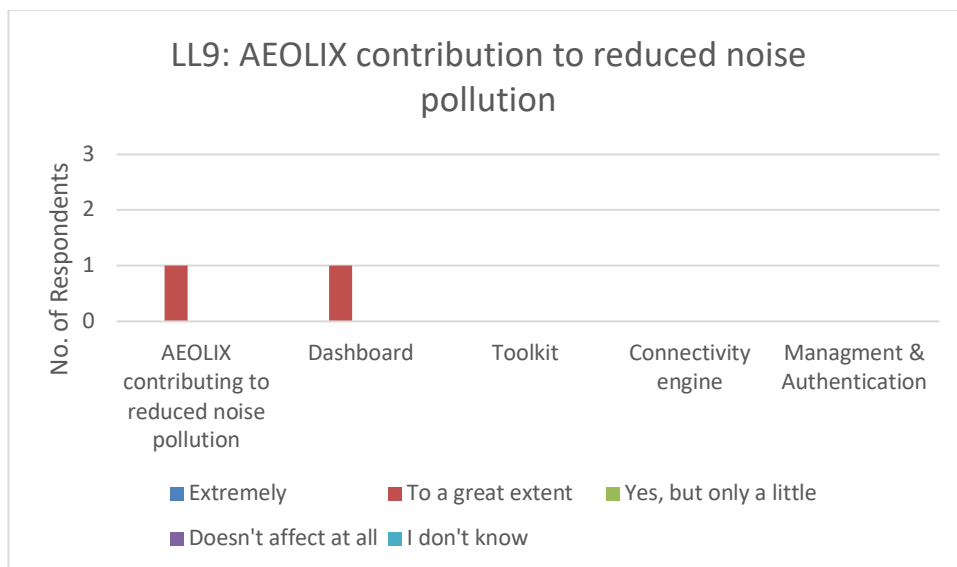


Figure 137: AEOLIX contributing to reduced noise pollution at LL9

The analysis of the results shows that AEOLIX in general and Dashboard function has helped a lot in reducing noise pollution. The main activities involve automatic alerts generation and reporting on delays and cancellations. Data from TX on status can now be seen on Dashboard with retyping.

5.9.3. LL9 Socio-economic Aspects

Socio-economic aspects include job creation, SMEs empowerment, and Improved quality of life. A short description of each is presented in the following paragraphs:

Job Creation

AEOLIX doesn't seem to have any impact (already happened or anticipated) on job creation for LL9 as shown in Figure 138 below. This may be due to little use of AEOLIX in the companies within LL9.

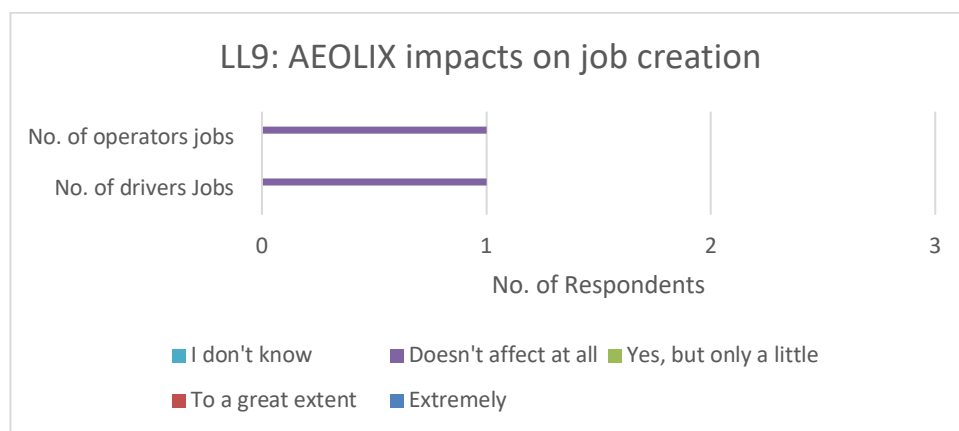


Figure 138: AEOLIX impact on job creation at LL9

SMEs Empowerment

Similarly, it seems that AEOLIX doesn't have any impact on SMEs empowerment within LL9. One of the reason include that Jan de Rijk is a large organization with about 1300 employees. They were unable to provide benefits that could be brought to SMEs through increased collaboration with them or sharing market share with SMEs. Following Figure 139 shows this perception:

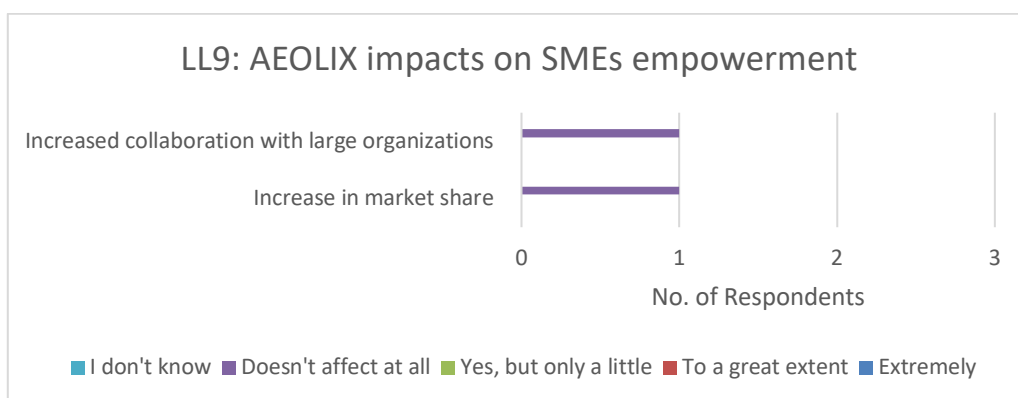


Figure 139: AEOLIX impact on SMEs empowerment at LL9

Improved Quality of Life

On the other side, AEOLIX has a positive but ‘only to a little extent’ impacts on reducing stress at daily work and putting more focus on work. However, this little impact is can be seen as improving employees’ life at work little by little. On the other hand, AEOLIX does not affect at all on the aspects of reward (e.g. less working hours) and positive change in people attitude towards the employees using it. The following Figure 140 presents the summary of results:

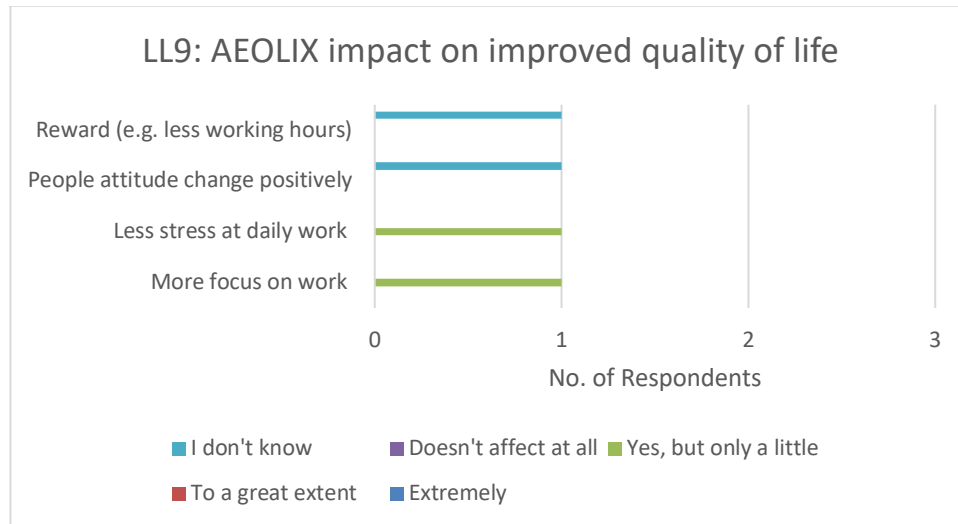


Figure 140: AEOLIX impact on improved quality of life at LL9

5.9.4. Acceptance and Trust of AEOLIX at LL9

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. This study asked question on how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. Unfortunately, we did not get much responses on most of the aspects related to acceptance and trust on AEOLIX. This is very unusual as compared to other living labs responses. The only respondent at LL9 have been AEOLIX Dashboard for less than 40 hours per month. However, the respondent does not have any opinion on if AEOLIX has been easy to learn or not. The respondent had the perception that AEOLIX will support managing operational change management (before) and is expecting that it will generate new options as well (after). Rest of the aspects related to acceptance and trust on AEOLIX remained unanswered. Therefore, no analysis can be made about acceptance and trust on AEOLIX for LL9.

5.10. LL10 Operational Impacts Assessment

LL10, Galicia, is located in the north west region of Spain and is focused on network optimization activities. The area is not crossed directly by any of the TEN-T corridors but there is a high potential use mainly in Mediterranean and Atlantic. The living lab was aimed at the cooperation and information exchange between automotive suppliers through AEOLIX that would allow:

- Searching of synergies between companies which allow optimizing of freight transport in existing routes.
- Balancing in-bound and out-bound, taking advantage of empty returning trucks and returnable packaging recovery.
- Creating new routes according to potential new needs generated by returns (opportunities identifying).
- Traffic avoidance /congestion reduction through modal shift: The reduction in the number of transports and trucks will lead in a traffic flow improvement and a reduction of congestion in the roads around Cluster area.
- CO2 reduction: To be determined with benchmarking, estimated in around 16% comparing current trip and trucks distribution with the potentially achievable.
- Cost reduction: Cost reduction derived from fuel consumption savings could be estimated in around 16% (related with CO2 reduction).
- Cash flow improvement in conservative estimation could be around 3-5% which is a considerable amount of money taking into account that we are considering a really high production volume of each component.
- Service level increase: Both Galician Automotive Cluster and their customers will be more competitive with higher service levels in their ability to respond to market demand, change orders, and emergency orders.

The respondents within living lab 10 represents three companies with 200 and 300 employees. Number of employees for the third company is not known. However, the average experience of employees at all three companies is more than 6 years. The companies have shipper customer or consignee and shipper manufacturer roles in supply chain. All companies operate in the urban areas, domestically and internationally. These companies are involved in the following types of groups of products:

- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
- Textile and textile products; leather and leather products

To ship these products, these companies used road freights as a mode of transportation including palletized goods, solid bulk good, and large freight containers.

Quick Wins

LL10 using the AEOLIX and Co-Trailer applications have the following quick wins as presented in Table 38 below:

Table 38: Quick wins at LL10

Factor	Quick Wins description
Business advantages – Mutual value creation	<ul style="list-style-type: none"> • increase visibility in terms of synergies and of locating logistics operators in geographical points within the region • increase the logistics optimization • increase the load factor • improve service levels • quality/safety monitoring • increase competitiveness
Critical factors for growth – Growth capacity or achievements	<ul style="list-style-type: none"> • increase horizontal collaboration to achieve network optimization • synergies between companies that facilitate the optimization of freight
Transferability – Best practices to share	<ul style="list-style-type: none"> • Improve communication among companies with potential synergies • facilitate collaboration and information sharing
Cooperation improvement – New Business Model	<ul style="list-style-type: none"> • locate offers and new logistic operators • improve the resources and capacity utilization
Cost/Benefit – Big changes	<ul style="list-style-type: none"> • reduce stock and stock management • Economical savings in the logistic cost

LL8 10 has measured a number of KPIs including:

- Average fuel consumption
- Average number of trips with consolidated cargo
- % of load factor
- Average CO₂ emission
- Financial benefits
- Acceptance and trust

These KPIs impact on various aspects at the operational level within LL10. For example, reduction in carbon foot prints is mainly dependent on reduction in average CO₂ emission. Similarly, reduction in operational business cost is dependent on number of KPIs including fuel consumption, number of trips with consolidated cargos, load factor and financial benefits gained by different companies within LL10.

5.10.1. LL10 Business Aspects – Reduced Operational Costs

LL10 collected similar data to LL3 before and after the implementation of the Co-Trailer application. Specifically:

- Distance of shipment in kms. Specifically, the origin and the destination of the shipments were used to get the total amount of kms that were travelled for the delivery of the shipments.
- Type of truck that was used for the transport of the shipment. The trucks were differentiated based on their load capacity.
- Weight of the of the loaded shipment.
- Information on the consolidated shipments after the implementation of AEOLIX platform were provided.

Calculations were conducted as described in LL3 and the results are presented above. It should be mentioned here that before the Co-Trailer application of the platform all the trips in LL10 presented a low level of consolidation with a load factor of 31%. After the implementation of Co-Trailer LL3 managed to consolidate 120 to 60 trips. Table 39 compares the fuel consumption, emissions and load factor between consolidated and unconsolidated trips. When we compare unconsolidated trips before and after Co-Trailer the results are the same. However, LL10 managed to achieve a 103% $((63\%-31\%)/31\%)*100\%$ increase in the load factor after the consolidation achieved by Co-Trailer. This increase in the load factor is also reflected in more efficient and environmentally friendly operations. Specifically, average fuel consumption and emissions went down by 75% $((0,020-0,036)/0,036)*100\%$.

Table 39: Summary of KPIs benefits at LL10

Business impacts LL10	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Reduction in fuel consumption (l/tkm)	25-30%	0,036	0,02	-44,44%	
Increase in% of consolidated trips	25-35%	0	60	43,48%	61% increase in consolidated trips
Decrease in % of empty runs ()	25-40%	Not measured			Not measured
Increase of % of load factor (CBM or weight)	35-40%	31%	63%	103%	32% increase of % or load factor
Reduction in average CO2 emission (kg/tkm)		0,116	0,066	-43,10%	
Administration work (hours)		1,25	0,33	-73,60%	

LL10 was able to collect data from more trips after the implementation of the AEOLIX platform. Co-Trailer enabled the consolidation of 60 trips out of 359 (16%) while before AEOLIX 0 out of the 126 trips were consolidated. We calculate AEOLIX impact using average (l/tkm or CO2e/tkm) to ensure that results are not influenced by the increased amount of data available after AEOLIX. Following Figure 140 shows all the benefits are shown in percentage against the set target of network optimization category of living labs, to which LL10 belongs to:

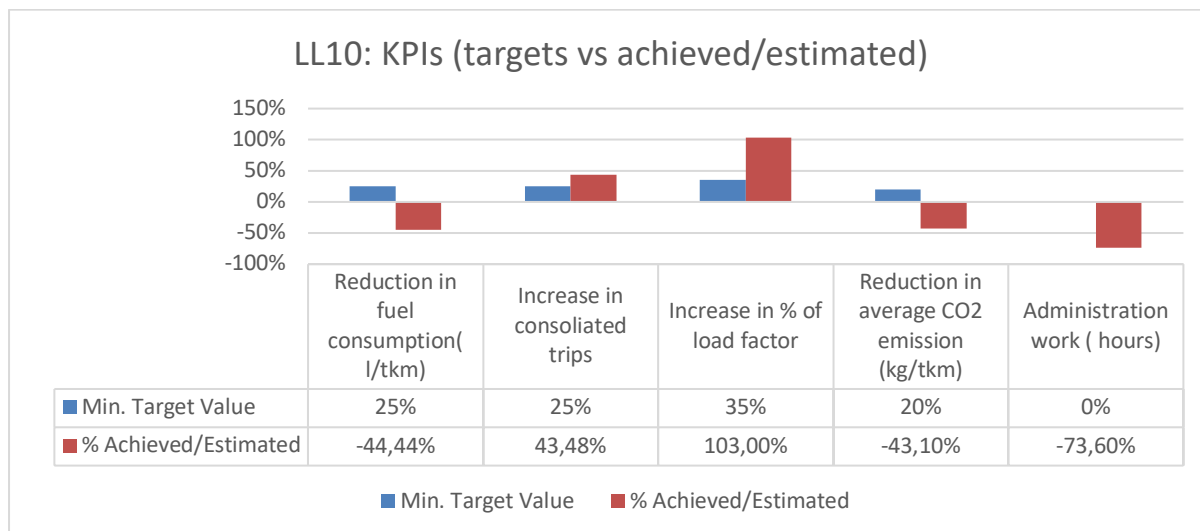


Table 40: KPIs benefit in % at LL10 (target vs achieved)

Reduction in Fuel Consumption

AEOLIX proved to be of great help when it comes to reduction in fuel consumption at LL10. In the above paragraphs, a description on reduction in fuel consumption methodology is described. Before co-trailer, there were only non-consolidated trips with average fuel consumption of 0.036 (l/tkm). However, AEOLIX lead to consolidation of trips leading to two fuel consumptions – one for unconsolidated trips with value of 0.036 (l/tkm) and the other for consolidated trips with value of 0.020 (l/tkm). It should be noted that the average fuel consumption remained unchanged for non-consolidated trips. For consolidated trips, the change results in 0.015 l/tkm reduction in fuel consumption. This accounts for 44% reduction in average fuel consumption for LL10 which is way more than the target value of 25%. The reduction in fuel consumption is shown in Figure 141 below:

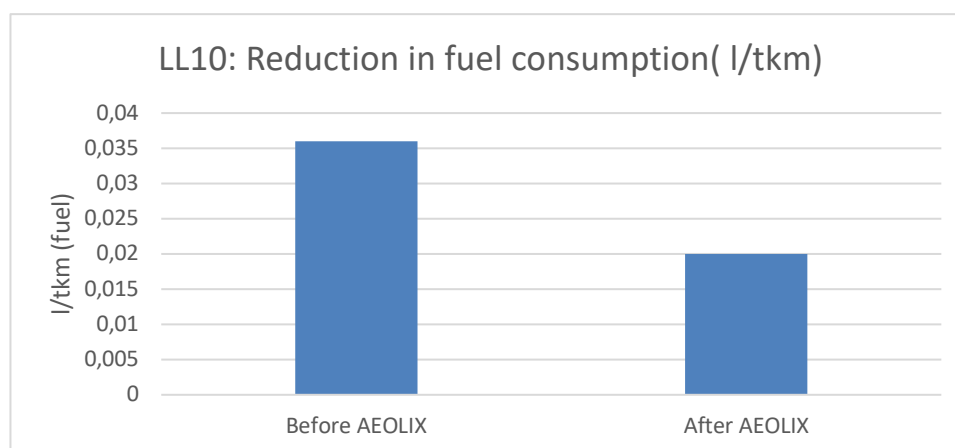


Figure 141: Fuel consumption at LL10 (before & after AEOLIX)

Increase in Consolidated Trips

As mentioned earlier, LL10 has gained a lot of increase in number of consolidated trips. Before AEOLIX, there was no consolidation for LL10. However, LL10 was able to obtain 60 consolidated trips or shipments with the help of AEOLIX. The values are shown in Figure 142 below.

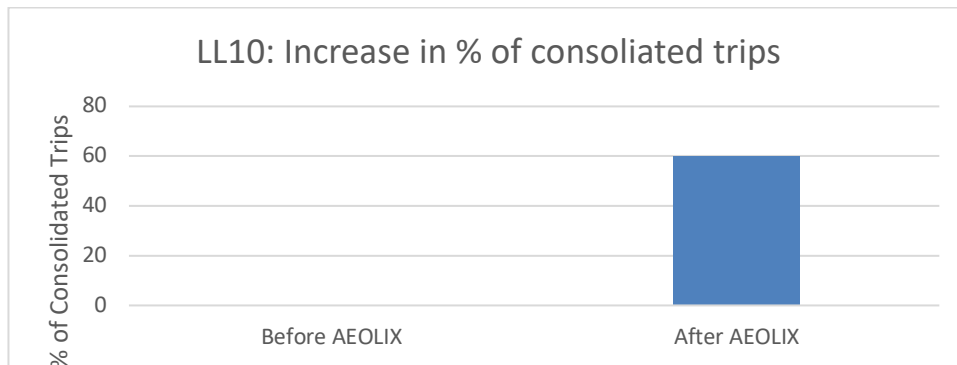


Figure 142: Consolidated trips at LL10 (before & after AEOLIX)

Increase in % of Load Factors

Increase in load factor has been a crucial phenomenon as this affect reduction in fuel consumption, consolidation and reduction in carbon footprints. Like fuel consumption, increase in percentage of load factor is measured before and after co-trailer. Before co-trailer the percentage of load factor valued at 31% for non-consolidated trips at LL10. The value remains unchanged after co-trailer for unconsolidated trips. However, this value in percentage of load factor was changed to 63% after co-trailer for consolidated trips. In terms of load factor, the difference for consolidated trips is 32% for LL10. This account to a huge gain by 103% increase in percentage of load factors. Following Figure 143 shows the values for percentage in load factors before and after AEOLIX. This increase in percentage of load factor is way more than the targeted value of 35-40%.

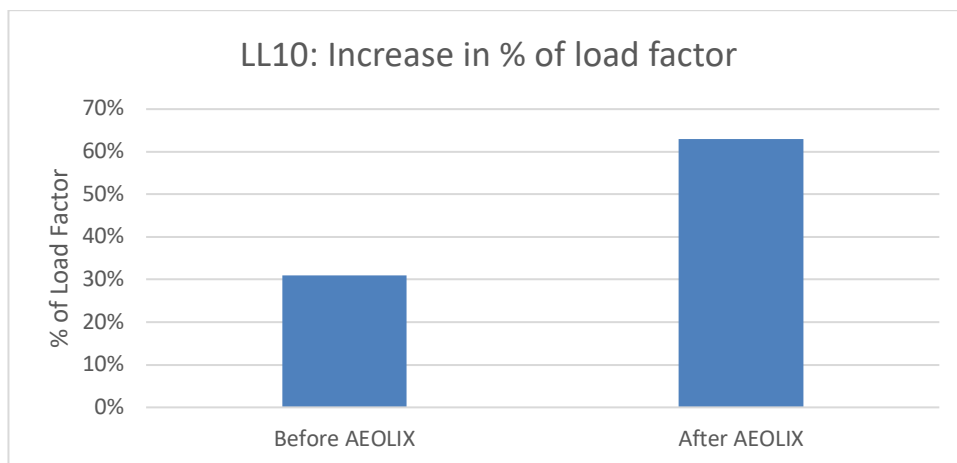


Figure 143: Percentage of load factor at LL10 (before & after AEOLIX)

Administrative Work

AEOLIX has been of a great help in saving time spent on administrative processes at LL10. The living lab was able to reduce the time spent on administrative work from 1.25 hours to 0.33 hours. This means that LL10 was able to save 73% of its time spent on specific administrative processes. Following Figure 144 shows the value of time spent on administrative work before and after AEOLIX.

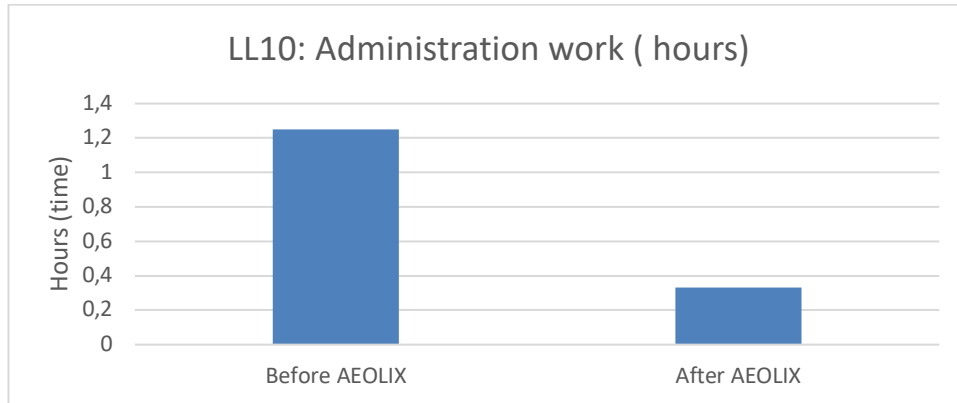


Figure 144: Administrative work benefits at LL10 (before & after AEOLIX)

In terms of hardcore financial benefits, LL10 was able to save values for two types of costs including the cost for logistics management. The cost is specifically associated with planning and quote request costs. This refers to how long does it take a logistics technician to plan loads, destinations, times and request quotes from logistics operators and select one for a particular route without Co-Trailer, and how long do you need for the same action with the app Co-Trailer (marketplace). There's been a change of culture. Without the Co-Trailer application, logistics technicians were asking logistics operators for a quote by phone. According to the companies, the average is usually 1:15 hours (including cargo data, destinations, timetables, bid search and selection of one). With the Co-Trailer application, the logistics technician only has to upload the route, look for synergies and with a simple click, sends the information to all logistics operators in the marketplace of the Co-Trailer application. The time needed by the logistics technician to do the same task is 0.33 hours (20 minutes). The salary cost (including social charges) of a logistics technician in 2019 is 38,000 euros/year, divided by 1,720 hours of work per year, is equal to 22 euros/hour. Therefore, LL10 was able to reduce the cost on logistics management by 73% which is a much higher achievement against the set target of 5.50-6% reduction in costs related to logistics management. A summary is shown in Figure 145 below:

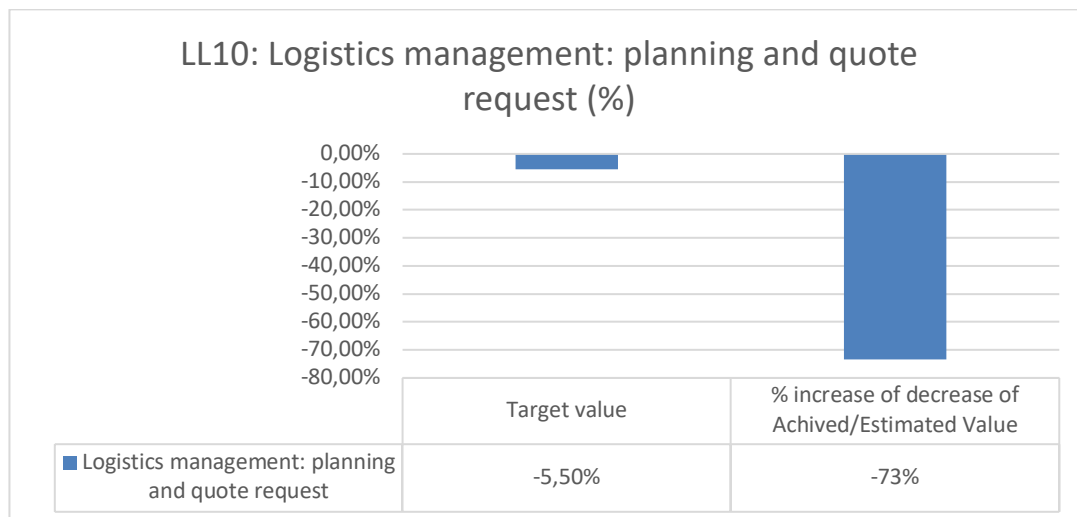


Figure 145: Logistic management cost savings in % at LL10 (target vs achieved)

5.10.2. LL10 Environmental Aspects

AEOLIX was able to have positive impacts on environmental aspects of reduction in CO₂ emission and noise pollution. A description of each is presented in the following paragraphs.

Reduced CO₂ Emissions

Reduction in carbon footprints is directly dependent on reduction in average fuel consumption and increase in percentage of load factor at LL10. The average CO₂ emission before co-trailer for non-consolidated trips was 0.116 kg/tkm. There was no value of CO₂ emission available for consolidated trips as there was no consolidation. After co-trailer, the average CO₂ emission was 0.116 kg/tkm for non-consolidated trips which is the same value as before co-trailer. However, the value for consolidated trips reached to 0.066 kg/tkm counting to different of 0.050 reduction in average CO₂ emission. This means that LL10 was able to reduce CO₂ emission by 44% with the help of AEOLIX which is considered as a high achievement. The values of CO₂ reduction at LL10 is shown in Figure 146 below.

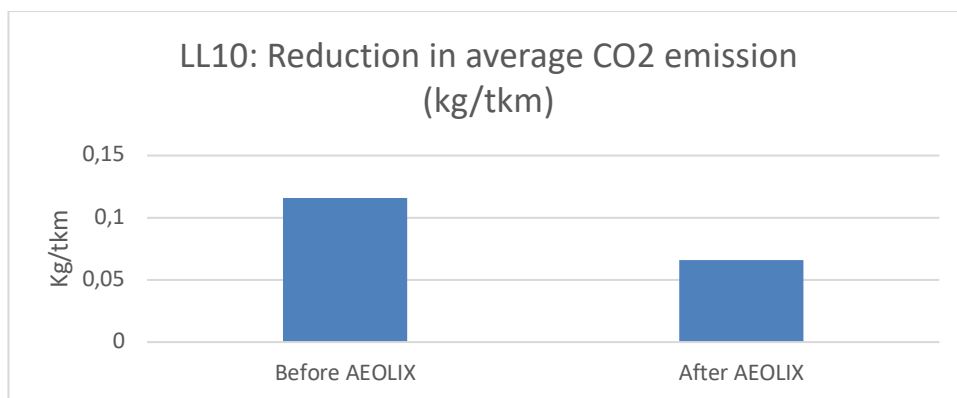


Figure 146: Carbon footprints at LL10 (before & after AEOLIX)

Reduced Noise Pollution

AEOLIX, in general, has positive impact on reducing noise pollution. The analysis of results shows that two of the functions, management & authentication and connectivity engine, have been of a great help in reducing noise pollution at LL10. However, there are no opinions of LL10 evaluation manager on the usefulness of Dashboard and toolkit in reducing the noise pollution. The results are shown in figure below.

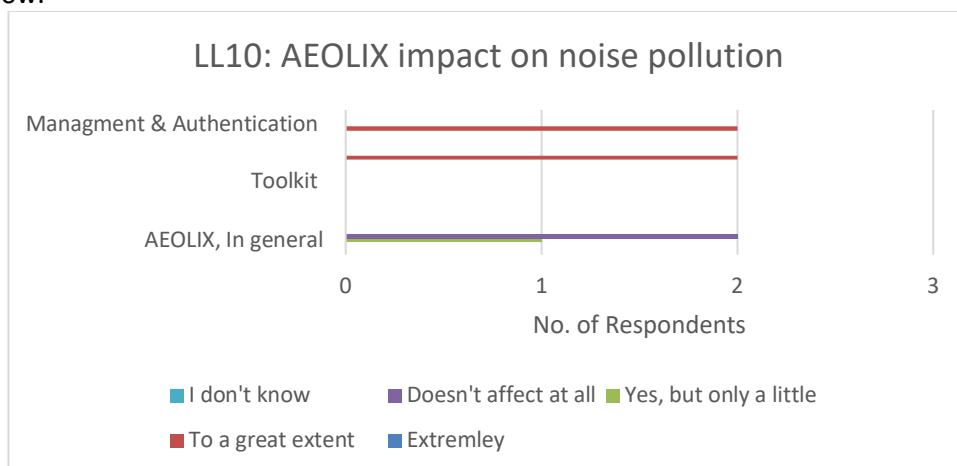


Figure 147: AEOLIX impact on reduced noise pollution at LL10

5.10.3. LL10 Socio-economic Aspects

AEOLIX has some impacts on various socio-economic aspects. A description of these impacts is shown in the following paragraphs.

Job Creation

One important aspect of AEOLIX impact on socio-economic aspects is number of jobs created as the result of use of the system. The analysis of results, however, shows that manager at companies within LL10 are unaware of the existing of future impact of AEOLIX in creating new jobs. Following Figure 148 shows summary of these results:

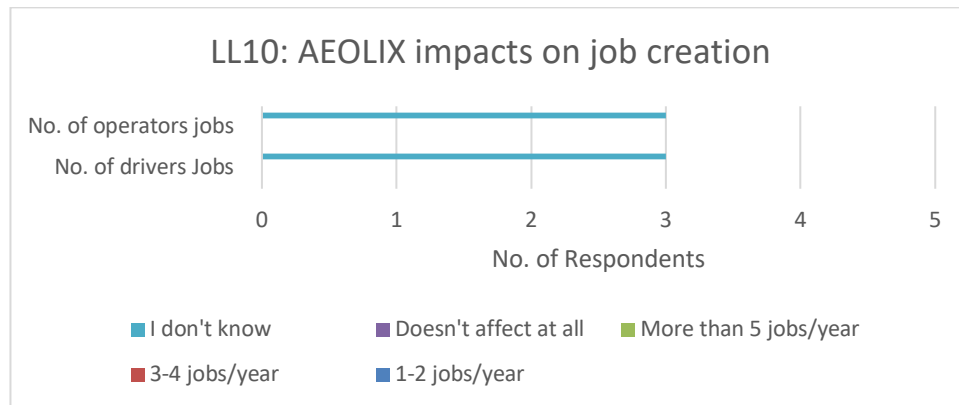


Figure 148: AEOLIX impact on job creation at LL10

SMEs Empowerment

SMEs empower is another important socio-economic impact including: increased collaboration with large organization and increase in market share. Regarding AEOLIX helping SMEs increased collaboration with large organizations, managers at companies are either unsure about the impact or think that there will be 'but only a little' impact. Furthermore, respondents are again unsure or think that there will be no effect at all where AEOLIX is helping to increase in market share. Following Figure 149 shows summary of results.

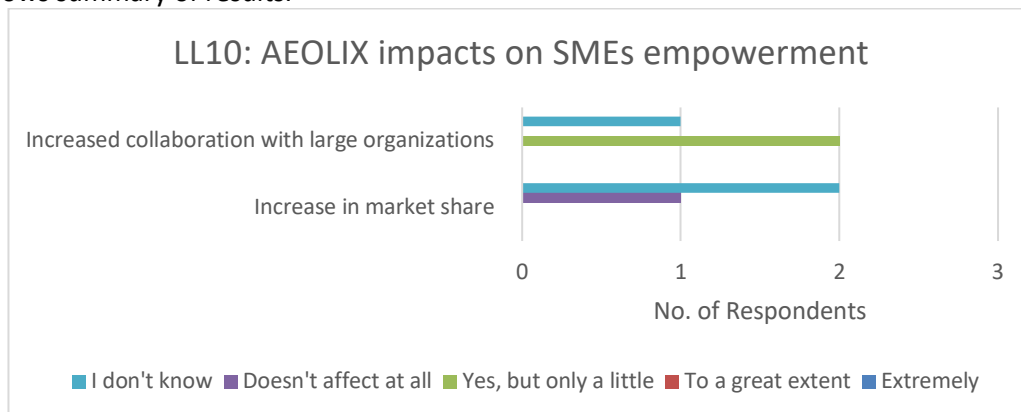


Figure 149: AEOLIX impact on SMEs empowerment at LL10

Improved Quality of Life

AEOLIX was supposed to help employees in number of areas related to improved quality of life at LL10. The analysis of the results shows variation in responses for three out of four aspects. These aspects include more focus on work, less stress at daily work and reward in the form of less working hours. One third of participants shared the views that for AEOLIX has helped 'to a great extent'. While another one third think that AEOLIX has helped in these three area 'but only to a little' extent. The rest one third of respondent think that AEOLIX has not helped in putting more focus on work, reducing stress at daily work, or rewarding employees. Finally, two third of respondents thing that the use of AEOLIX did not help employees at operational level to get positive responses from their colleagues. One third, however, share the view that AEOLIX has helped employees who uses it to get some recognition from their co-workers at companies within LL10. An overview is presented in Figure 150.

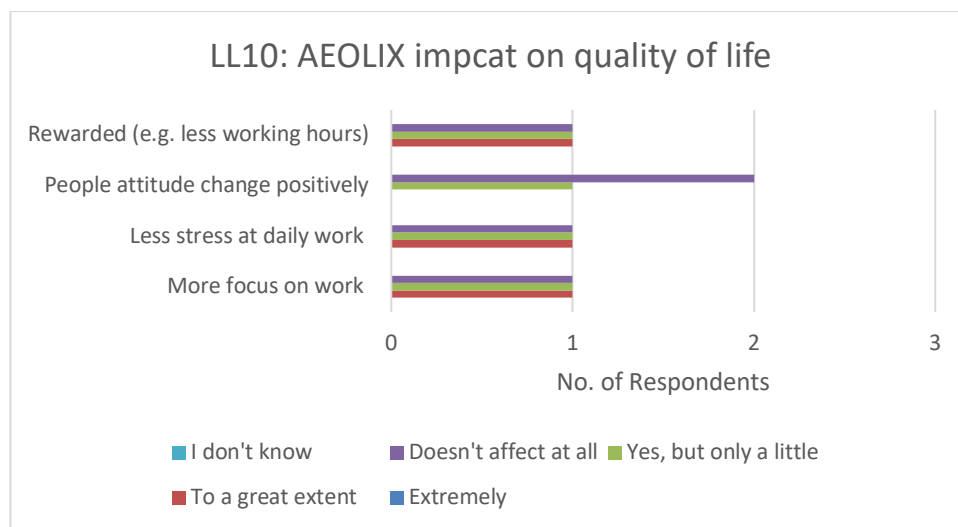


Figure 150: AEOLIX impact on improved quality of life at LL10

5.10.4. AEOLIX Acceptance and Trust at LL10

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis show that LL10 evaluation manager thinks that AEOLIX use is directly related to the degree of approval by users. However, change in AEOLIX acceptance and trust level impact improved planning and overall performance, increased responsiveness, and improved service level 'but only to a little' extent. Some of the factors for this little impact include the followings:

- At the moment, the new operations/procedure are not completely accepted.
- At the moment the users are using the platform, but they have suffered it as a forcing, so at the moment they see only slight advantages.

- Trust in the veracity of the found data, which means greater use and greater sharing of the platform.

Finally, there are number of areas where AEOLIX acceptance and high trust level is more important than others. These areas include improved efficiency of operations relationship with users and degree of approval of AEOLIX by users. A summary of these impacts are presented in Figure 151 below:

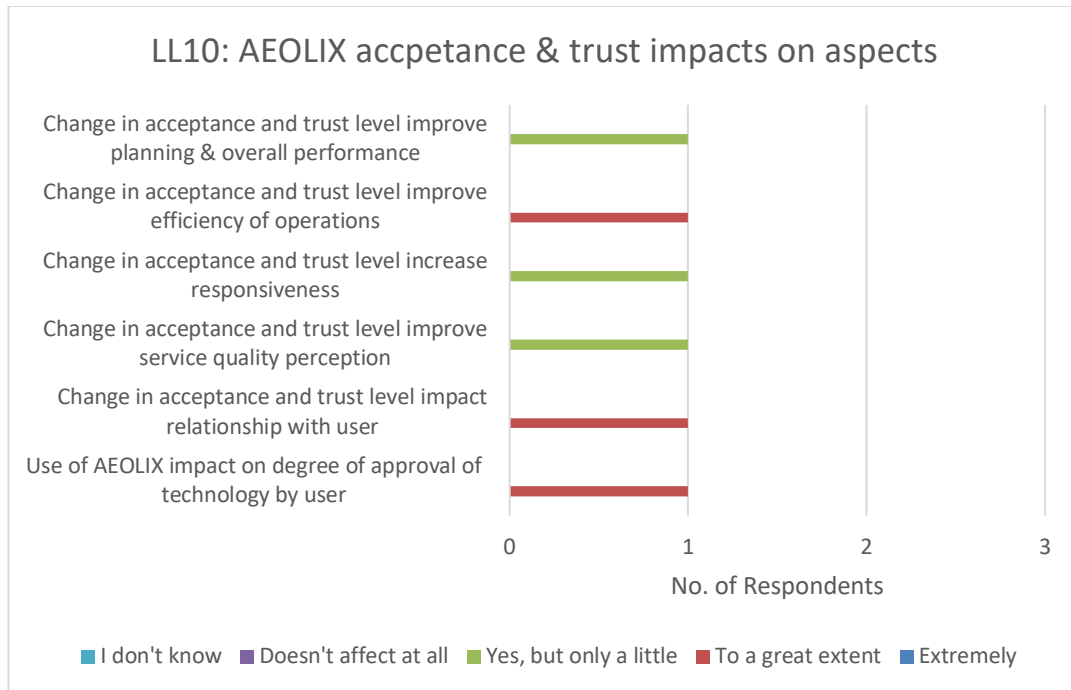


Figure 151: AEOLIX acceptance & trust impacts on various aspects at LL10

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 152 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL10 evaluation manager.

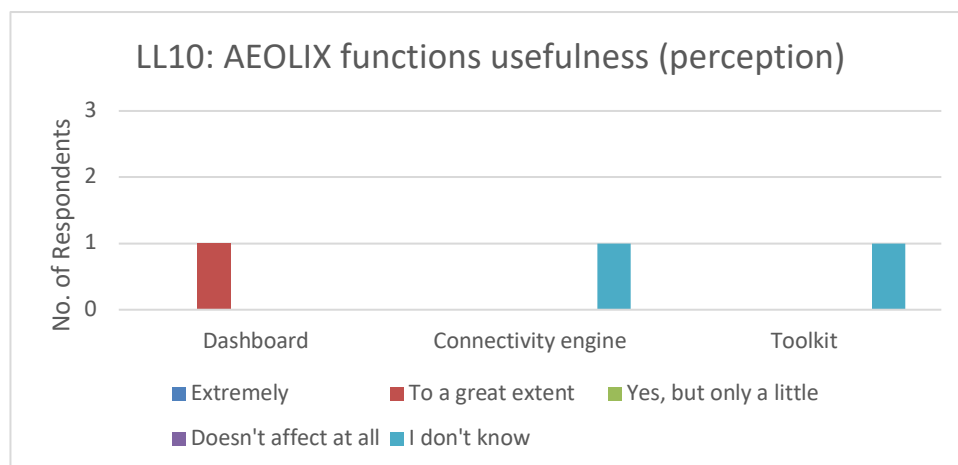


Figure 152: AEOLIX functions usefulness at LL10 (perception)

Only Dashboard was perceived to be useful to a great extent for various logistics activities at LL10. After using AEOLIX, LL10 evaluation manager was extremely satisfied with the usefulness of Dashboard. Although LL10 evaluation manager did not have any idea about the usefulness of connectivity engine and toolkit services, both of the functions proved to be useful ‘to a great extent’ for users at LL10. This highly perceived and experienced usefulness implies that LL10 trust on AEOLIX and already has an accepted AEOLIX solution for their business activities. Following Figure 153 shows the actual usefulness of AEOLIX functions.

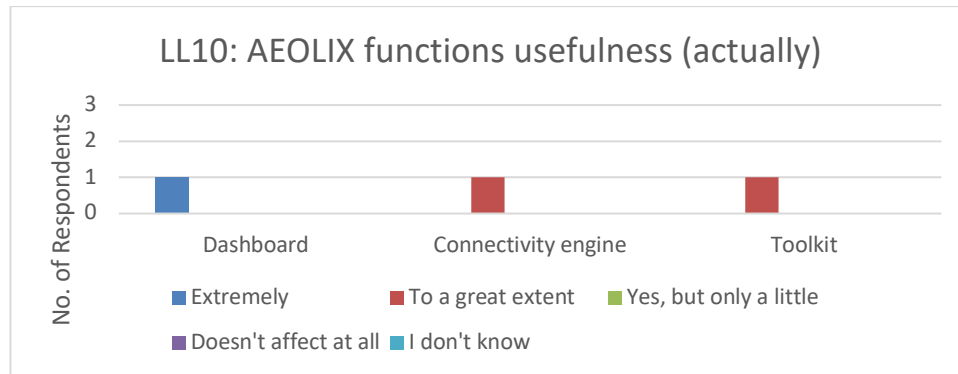


Figure 153: AEOLIX functions usefulness at LL10 (in actual)

This study further probed into the what was actually expected of AEOLIX and what users got. For LL410AEOLIX was perceived as a system for providing faster paperless procedures and better reallocation of workloads. Managers at companies are satisfied with the AEOLIX in meeting their expectations.

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users shows a full interest to continue using Dashboard at LL10. For connectivity engine and toolkit service, LL10 evaluation manager eager to continue using AEOLIX to a great extent. The willingness to continue using AEOLIX is directly related to the usefulness. Since the usefulness is rated very high, the willingness to continue using the system follows. The summary of respondents results on willingness to continue using AEOLIX is presented in Figure 154 below:

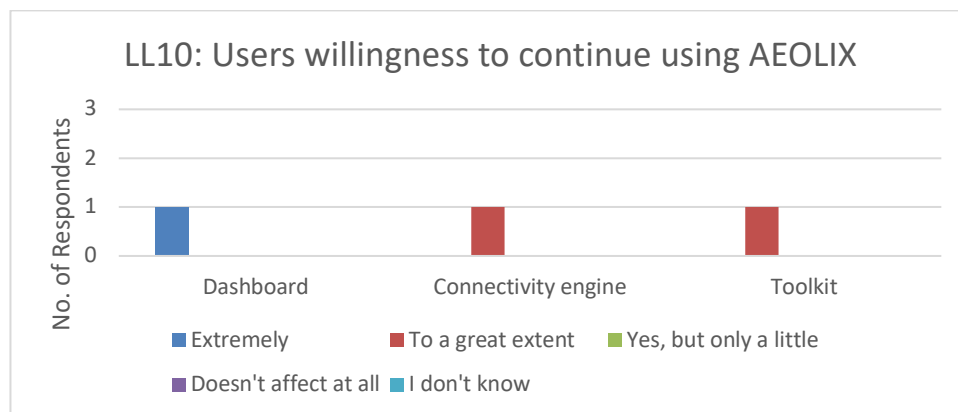


Figure 154: Users willingness to continue using AEOLIX at LL10

After willingness to continue using AEOLIX, we asked question about trust on various components: **To what extent, users trust on various AEOLIX functions?**

The results show that users completely trust on Dashboard in helping LL10 to perform various logistics activities. Furthermore, LL10 evaluation manger has also put his high trust on authentication and management services. However, LL10 evaluation manager is completely unaware of the performance of connectivity engine and toolkit services, therefore they do not have any opinion regarding trust on these functions. This is the result of average or even below average use of AEOLIX as well as the errors and problems occur during the use of the system. A summary of users trust on various AEOLIX functions is presented in Figure 155 below:

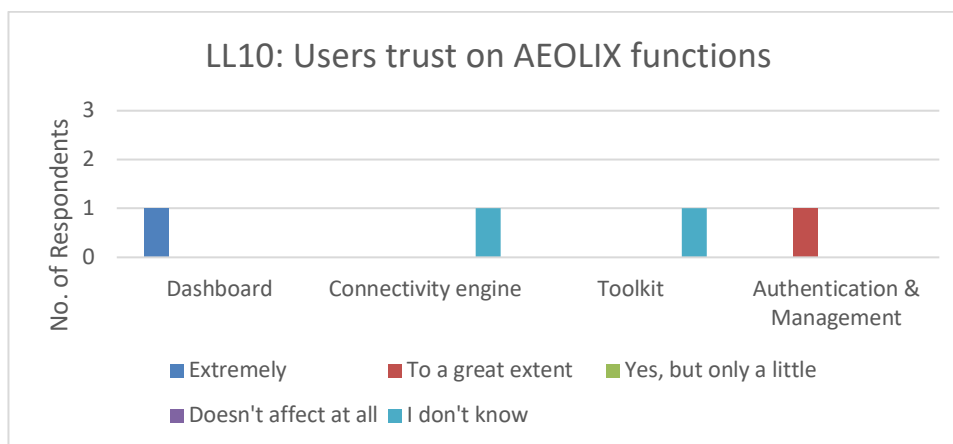


Figure 155: Users trust on AEOLIX functions at LL10

We further investigated number of aspects related to AEOLIX acceptance. The results are presented in the Figure 156 below:

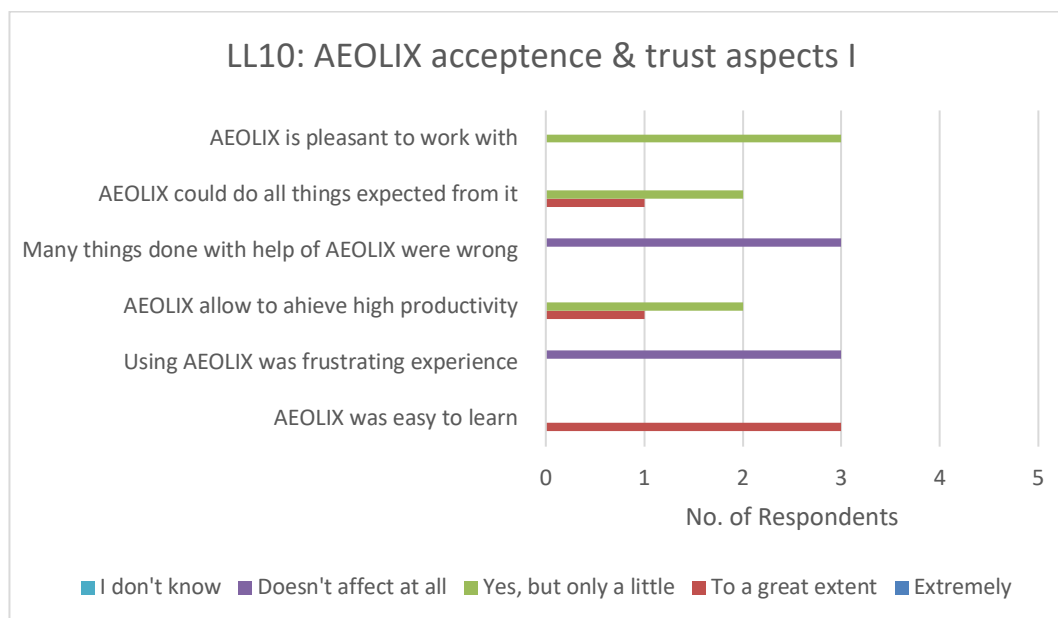


Figure 156: AEOLIX acceptance & trust aspects-I at LL10

The results depict that many respondents at LL10 agree ‘but only to a little extent’ with the view that AEOLIX was pleasant to work with. However, there are split views on (i) AEOLIX could do all thing expected from it; and (ii) AEOLIX helping to achieved high productivity. Two third of the respondents think that AEOLIX could do all things expected from it and helping to achieve high productivity, ‘but only to a little’ extent. On the other hand, one third of the respondents share the more optimistic view that AEOLIX could help to achieve high productivity and could meet all it expectation ‘to a great extent’. Other positive results include the followings: working with AEOLIX has not proved to be frustrated experience at all and things done with the help of AEOLIX were not wrong. All these positive results are reflected in the fact that AEOLIX proved to be easy to learn for LL10 users. These results are shown in figure above.

Last but not the least, we probed into further aspects related to AEOLIX acceptance and trust as shown in the Figure 157 below:

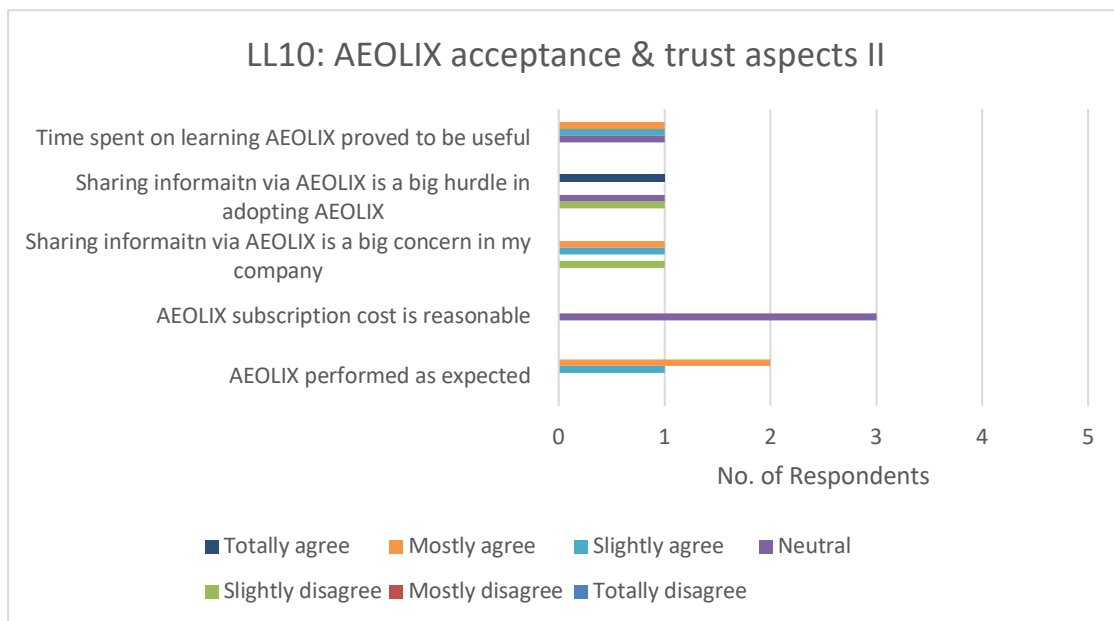


Figure 157: AEOLIX acceptance & trust aspects-II at LL10

All respondents ‘mostly agree’ or have ‘neutral’ opinion to the claim that AEOLIX proved to be useful for LL10 users. However, the respondents have split vies about sharing information via AEOLIX as a big hurdle in adoption of AEOLIX. One of the respondents think that sharing information via AEOLIX is hurdle in its adoption ‘to a little’ extent. However, another has a neutral view and the last respondent do not see sharing information via AEOLIX as a hurdle to its acceptance. On the contrast, sharing information via AEOLIX is considered as a big concern with LL10 to varying extent – mostly agree, slightly agree, and even slightly disagree. Furthermore, all of the respondent ‘mostly’ or ‘slightly’ agree that AEOLIX could meet its performance expectancy. Finally, all respondents are not aware of the AEOLIX subscription cost and have neutral views about the cost being reasonable or not for LL10.

5.11. LL11 Operational Impacts Assessment

Living lab 10 (LL10), Mondelez Load Control Centre Bratislava, is a type of intelligent hub. Mondelez Control Tower receives its transport orders manually from the Mondelez production plants. The inefficiency of the manual transport order handling results in higher transport management cost at the shipper side. AEOLIX will try to find solutions to improve data accuracy and reduce the cost of the direct transport management. Mondelez does not provide visibility on waiting time at the loading and the unloading locations to the carriers, which can result in waiting time of assets. AEOLIX was expected to provide visibility on waiting time to carriers. Mondelez as shipper does not receive visibility on the truck location from the carriers and cannot predict the estimated time of arrival. The late transport can cause loss of sales at the shipper side. One of AEOLIX performance expectancy was to visualize the truck location for the shipper. With the use of AEOLIX, LL11 is looking forward to meet some long-term goals including:

- Reduce direct cost of transport management on the shipper side
- Reduce the waiting time of the assets
- Reduce lost sales of the shippers due to late transport

To achieve these goals, LL11 measured number of KPIs including:

- Average number of trips with consolidated cargo
- Average waiting time
- Average loading/unloading time
- % of load factor
- Modal shift
- Visibility / data sharing
- Financial benefits
- Dynamic reconfiguration of shipments
- Acceptance and trust

The following Figure 158 shows that a number of KPIs impact on various aspects on operational level. The aspects of reduced noise pollution, CO₂ emission and reduced operational costs are affected by KPIs number of trips with consolidated cargo, waiting time of trucks at terminal, loading and unloading time, load factor, modal shift and dynamic reconfiguration of shipments.

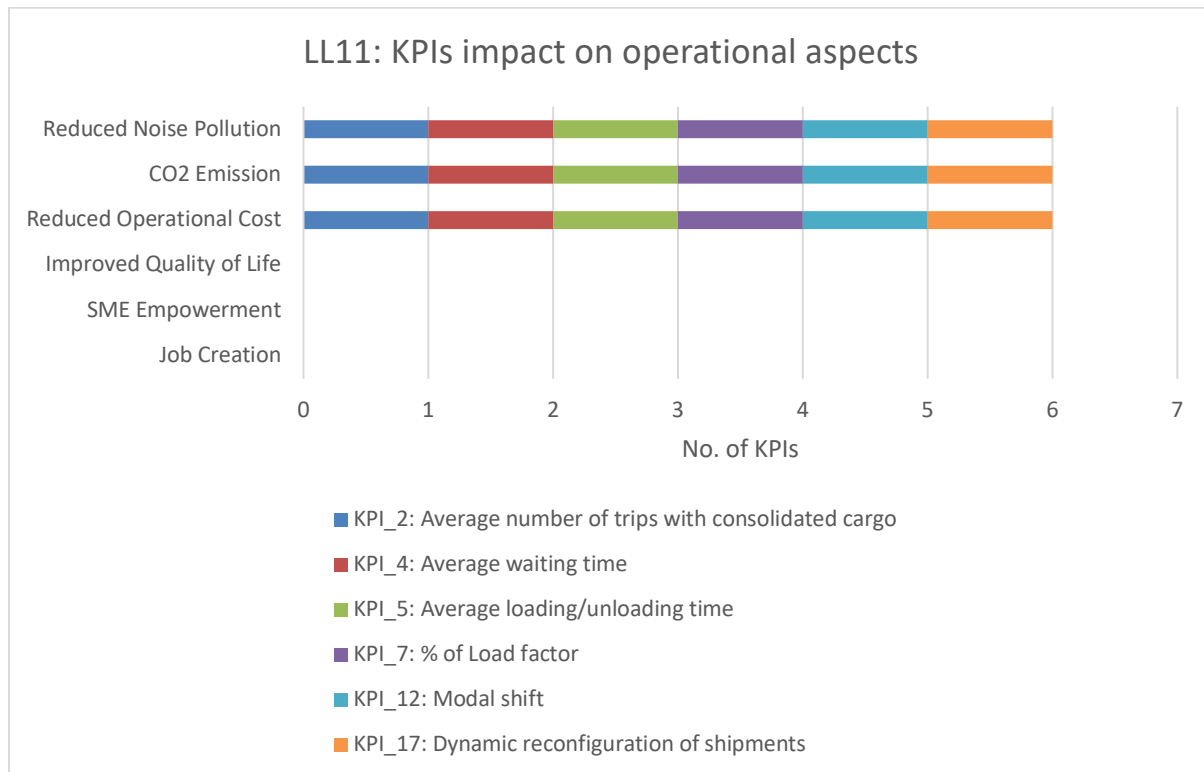


Figure 158: KPIs impact on various operational aspects at LL11

5.11.1. LL11 Business Aspects – Reduced Operational Costs

Following Table 41 shows summary of achievements with KPIs for LL11:

Table 41: Summary of KPIs benefits at LL11 (before & after AEOLIX)

Business impacts LL11	Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Reduction in fuel consumption (l/km; km/l; or l/tkm)	25-30%		90750		based on the below saved km. This is however just for informative purpose and double-reporting the same reduction (diesel and CO2) should be avoided!
Increase in consoliated trips	25-35%	100	110	10%	increase thanks to improved visibility via AEOLIX
Decrease in % of empty runs	25-40%	Not measured			Not measured
Reduction of waiting time for trucks in terminal	n/a	60000	30000	-50%	Currently run by TMS systems which will be incorporated in future; estimated impact as per D5.4

Increase of % of load factor (CBM or weight)	35-40%	80% cubic , 96% footprint	81% cubic, 99% footprint	3%	cubic utilization increase by 1% and footprint utilization by 3% overall.
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Reduction in Fuel Consumption

Though the target was set to 25-30% for LL11, the living lab was able to have a reduced fuel consumption with a value of 90750 liters. This value was based on the below saved kilometers. This is, however, just for informative purpose and double-reporting the same reduction (diesel and CO2) should be avoided.

Increase in Consolidated Trips

Due to increased visibility via AEOLIX, LL11 was able to enjoy increase in consolidated trips. Before AEOLIX, the percentage of consolidated trips was 100 and after AEOLIX trip was 110%. Thus, LL11 was able to increase the consolidate trips by 10% which is quite low as compared to the target value of 25-35%. These increase in consolidated trips brings benefits in terms of money and environment for the living lab. This increase in consolidate trips can also positively impact overall performance in cases where the living lab is facing delays in loading/unloading processes or delay due to ETA. However, this should be remembered that until the process is manual and automated interfaces are not established, the impact remains little.

Average Waiting Time

The average waiting time for trucks at the terminal is being organized by current TMS at LL11. At the moment, AEOLIX is not having a great influence on waiting times for trucks at the terminal. This is because the TMS system has not been integrated with AEOLIX yet. However, LL11 is planning to integrate TMS with AEOLIX. Once this is done, LL11 is expecting a huge benefit on waiting times. According to careful calculations, LL11 estimated to reduce the waiting time by 50% with the integration of TMS and AEOLIX. The main benefits will be achieved through better information visibility and sharing as well as with improvements in communication with drivers.

Increase in % of Load Factors

AEOLIX has helped LL11 to achieve the increase in percentage of load factor along two dimensions: increase in cubic utilization and footprint utilization. Cubic utilization refers to the space above the ground, and footprint utilization refers to the space on the floor. With the use of AEOLIX, LL11 was able to achieve the value from 80% to 81% resulting in 1% in cubic utilization. Similarly, LL11 was able to use up to 99% of the floor as compared to previous value of 96%. Thus, LL11 was able to increase the load factor in terms of increase in footprint utilization by 3%. Although LL11 was unable to achieve the value within target range of 35-40%, still the increase in percentage of load factor is important for two reasons: (i) release of more storage space along the loading site; and (ii) reduce number of trucks required to load.

A comparison percentages between target value and achieved or estimated is shown in Figure 159 below:

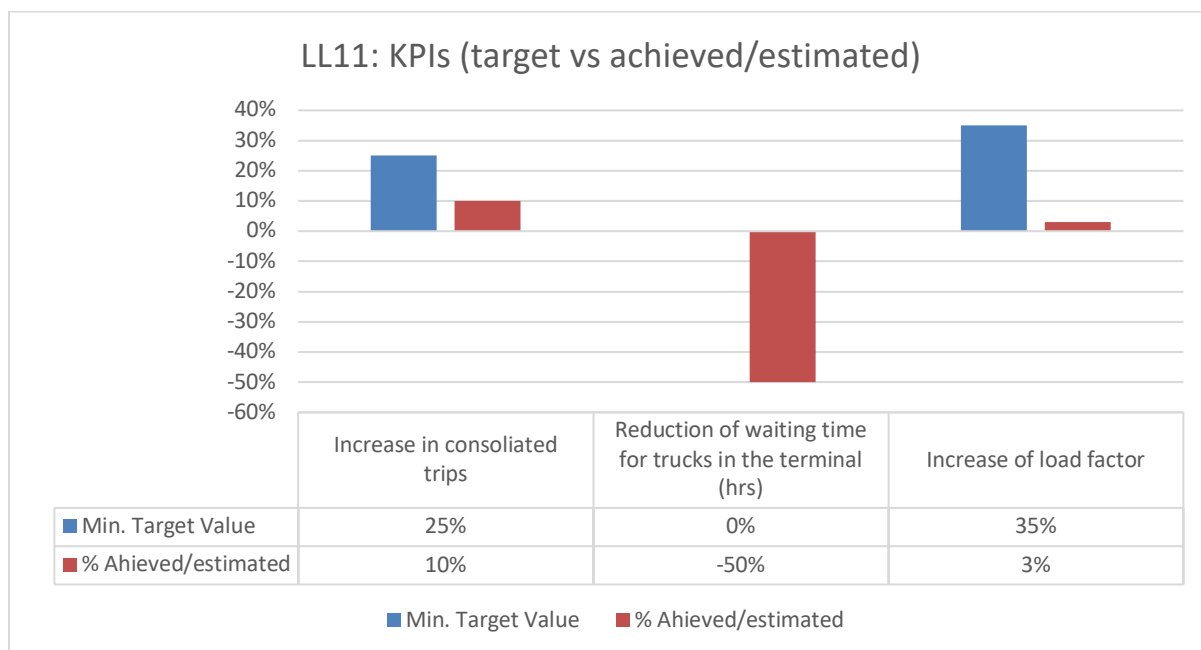


Figure 159: Summary of KPIs benefits in % at LL11 (target vs achieved)

The financial benefits with such a 1% increase in cubic utilization and 3% increase in footprint utilization is approximately 1 million USD, annually. This savings are related to the cost type 'trade management labor' and equal to 1% savings in the existing costs. This cost saving against the target value of 5% (as set in AEOLIX DoW) is shown in Figure 160 below:

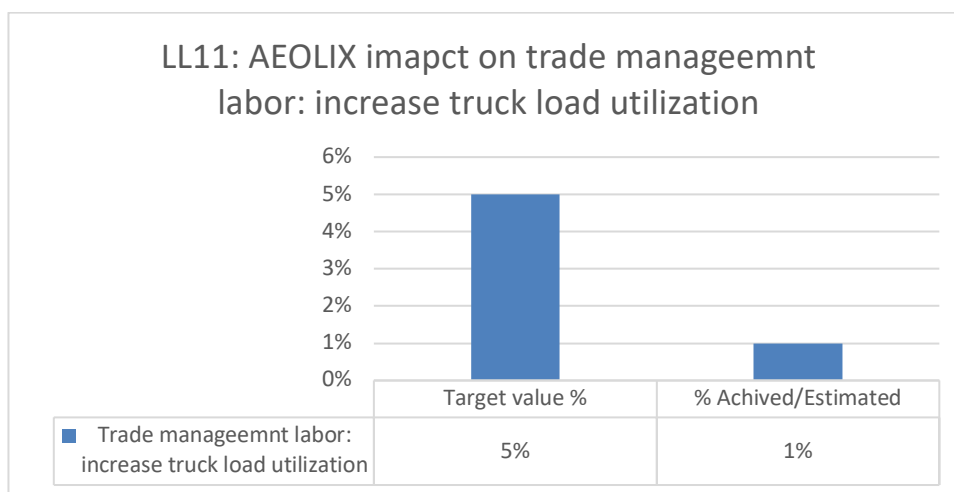


Figure 160: Trade management cost savings (target vs achieved)

5.11.2. LL11 Environmental Aspects

Environmental aspect includes the following two sub-aspects: reduction in average CO2 emission and reduction in noise pollution. The analysis of results for both of the aspects related to environmental impacts is provided in the following paragraphs.

Reduced CO₂ Emissions

Some basis for reduction in CO₂ emission were provided as follows:

- 11 truck saved DUE AEOLIX
- 500 KM
- 5500 KM saved per week
- 275000 per year
- 33 l/100 km is fuel consumption for trucks

Reduced Noise Pollution

Noise pollution has been another major aspect in measuring AEOLIX impact on environment. AEOLIX, in general, and Dashboard were conceived as having impacts on reduction in noise pollution. However, this impact is not considered to be of a great value meaning that AEOLIX helped LL11 to reduce noise pollution, 'but only to a little' extent. Following Figure 161 shows the summary of responses on AEOLIX helping to reduce the noise pollution.

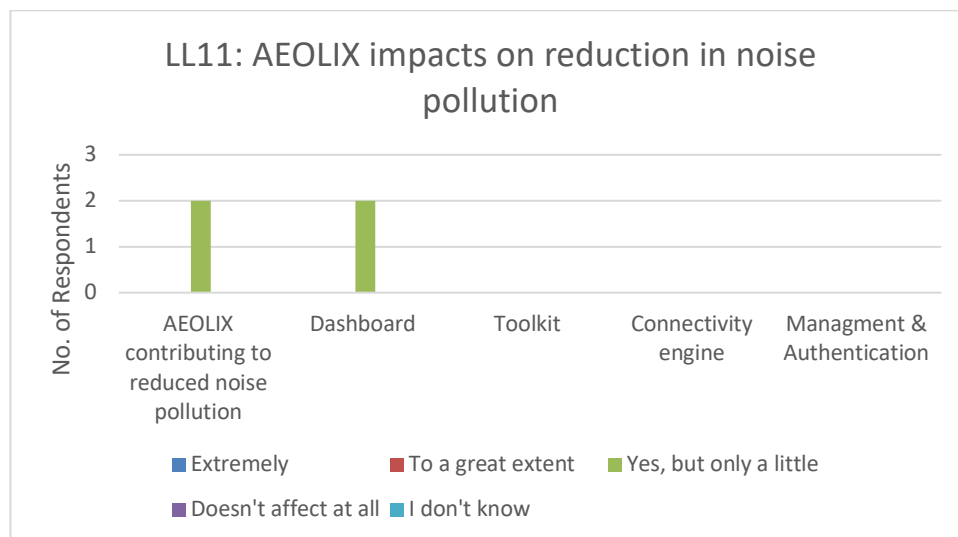


Figure 161: AEOLIX impact on reduced noise pollution at LL11

5.11.3. LL11 Socio-economic Aspects

Where AEOLIX is helping to have impacts on environment and business, its impact on socio-economic aspects cannot be ignored. The socio-economic aspects include job creation, SMEs empowerment, and improved quality of life. A short description for each is presented below.

Job Creation

It seems that respondents from LL11 are unaware of the actual or anticipated impact of AEOLIX on new operational level jobs for drivers or operators. Following Figure 162 provides the summary of results at LL11:

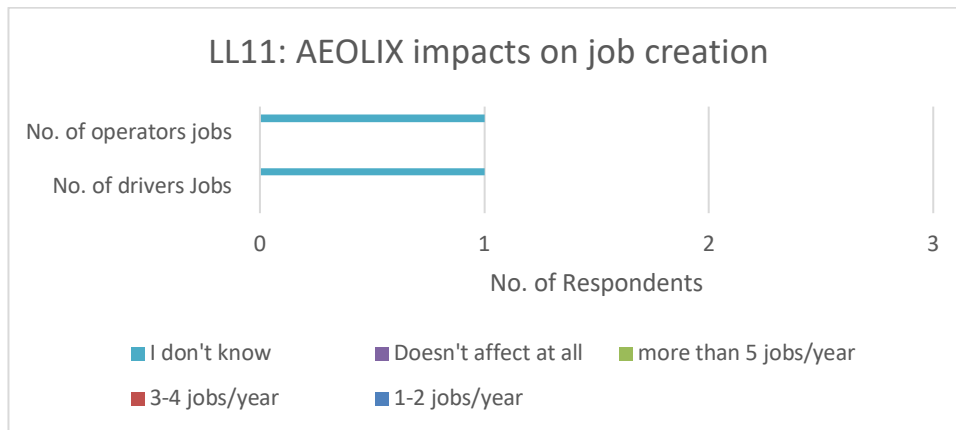


Figure 162: AEOLIX impact on job creation at LL11

SMEs Empowerment

Another important aspect that AEOLIX is expecting to contribute is SMEs empowerment at LL11. AEOLIX impact on both the aspects related to SMEs empowerment – increased collaboration with large organizations and increase in market share. But the AEOLIX impact varies in terms of the extent. AEOLIX can help ‘but to a little’ extent only for SMEs to have increased collaboration with large organizations. For an increase in market share, AEOLIX impact was divided between have an impacts ‘only to a little extent’ and ‘to a great’ extent. Following Figure 163 shows the summary of AEOLIX impact on SMEs empowerment.

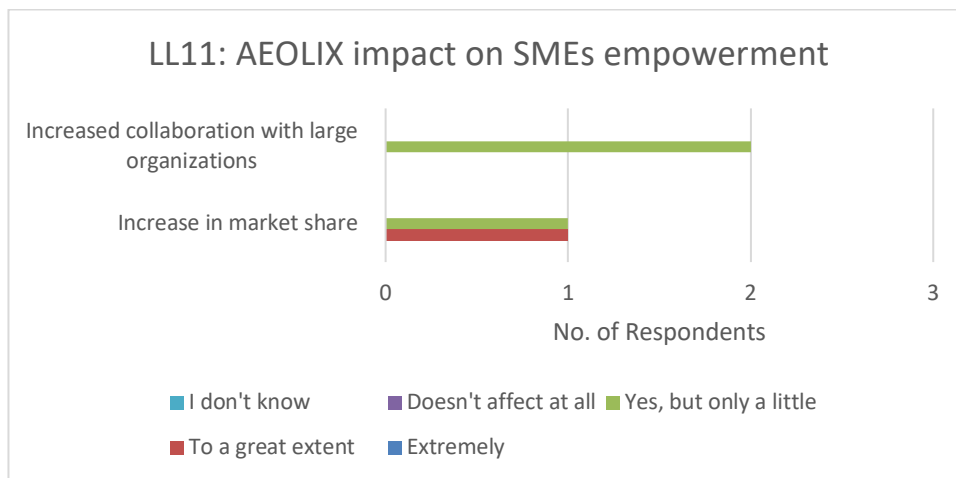


Figure 163: AEOLIX impact on SMEs empowerment at LL11

Improved Quality of Life

Finally, AEOLIX impact on improved quality of life has been seen as an important aspect where it contributes to socio-economic aspects. However, AEOLIX can be of help but only ‘to a little extent’ for all the aspects related to improved quality of life. These aspects include more focus on work, less stress at daily work, positive change in people attitude, and reward in terms of less working hours. Following Figure 164 shows summary of results on improved quality of life for employees with AEOLIX at LL11:

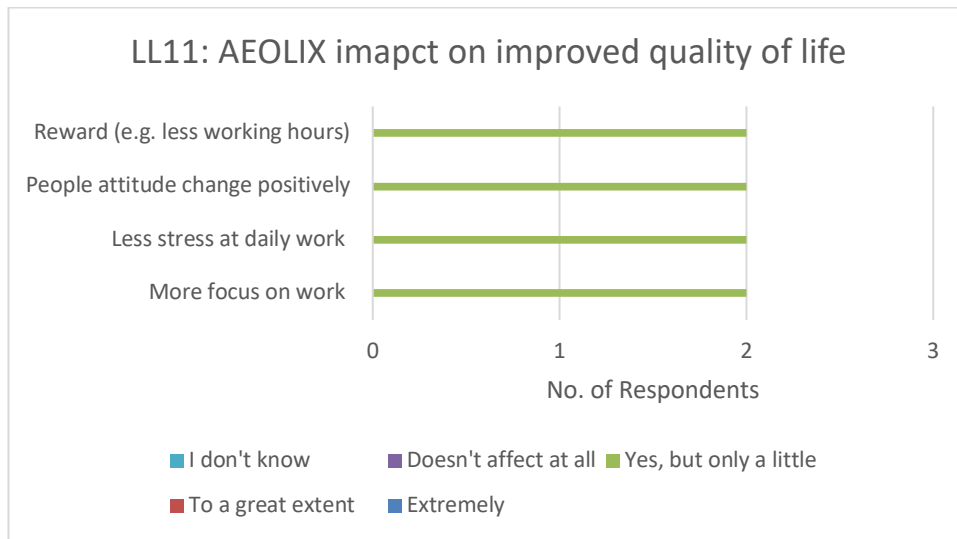


Figure 164: AEOLIX impact on improved quality of life at LL11

5.12.1. AEOLIX Acceptance and Trust at LL11

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis show that LL11 evaluation manager thinks that AEOLIX use is directly related to the degree of approval. However, change in AEOLIX acceptance and trust level impact improved planning and overall performance, increased responsiveness, improved efficiency of operations, and relationship with users 'to a great' extent. A summary of these impacts are presented in Figure 165 below:

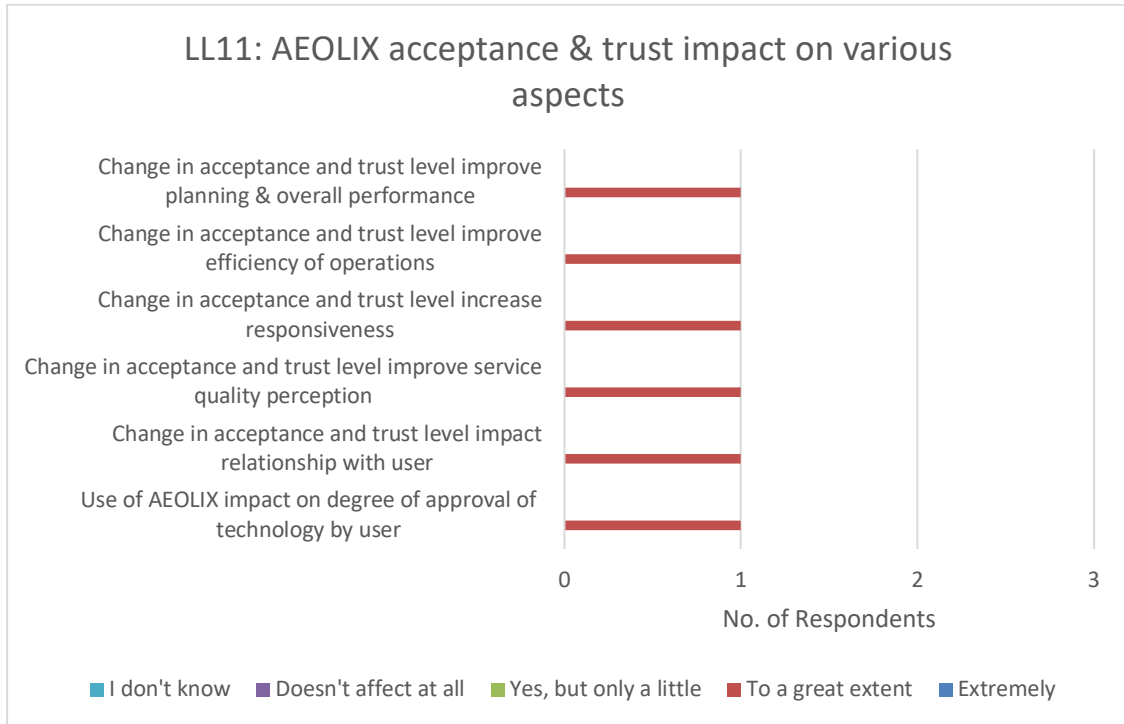


Figure 165: AEOLIX acceptance & trust impacts on various aspects at LL1

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 166 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL11 evaluation manager.

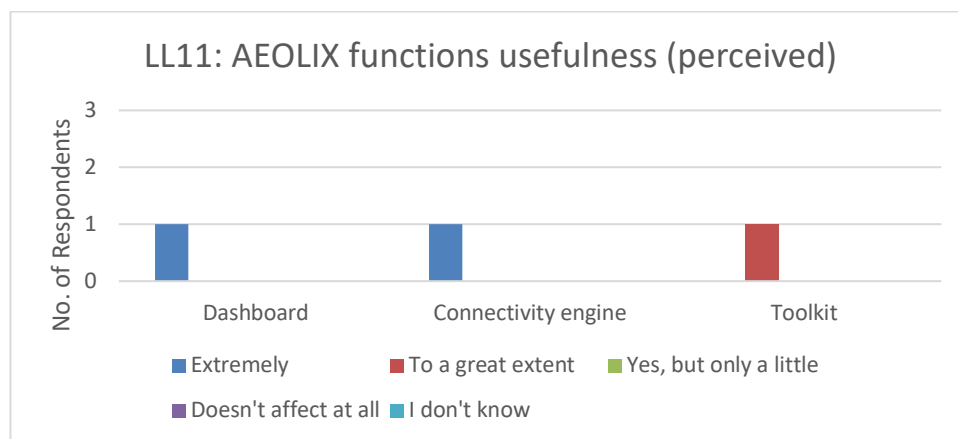


Figure 166: AEOLIX functions usefulness at LL11 (perceived)

Two functions, Dashboard and connectivity engine, were perceived extremely useful for LL11. However, both the functions were able to be useful 'to a great' extent which is not too bad of results. Only the toolkit services were able to meet its expectations of being useful 'to a great extent'. The actual usefulness of AEOLIX functions is presented in figure Figure 167. The results imply that the acceptance and trust on AEOLIX is very high, since the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system.

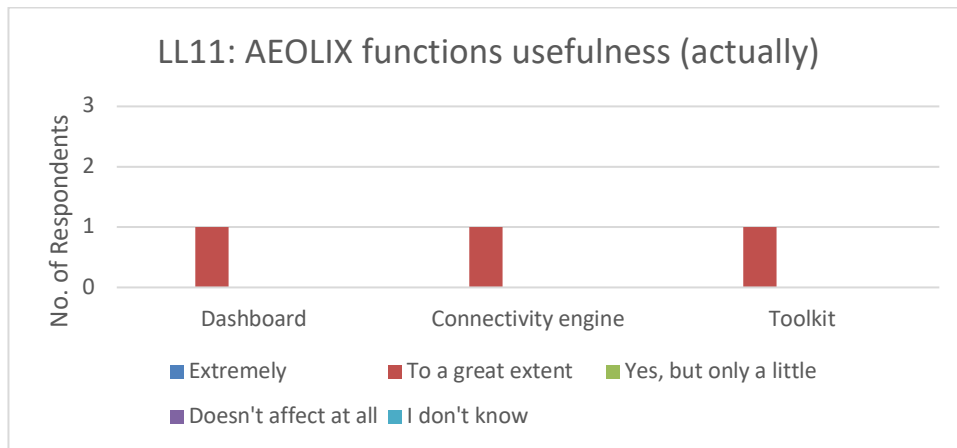


Figure 167: AEOLIX functions usefulness at LL11 (in actual)

This study further probed into the what was actually expected of AEOLIX and what users got. For LL11, AEOLIX was perceived as a system for providing faster paperless procedures and better reallocation of workloads. Managers at companies are satisfied with the AEOLIX in meeting their expectations.

The study continued to ask question about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The analysis shows that users were pretty much satisfied with the performance and meeting the expectations from all three AEOLIX functions – Dashboard, toolkit services, and connectivity engine. Users see value in all three functions are very much willing to continue using all three functions to a great extent. The willingness to continue using AEOLIX is directly related to the usefulness. Since the usefulness is rated very high, the willingness to continue using the system follows with positive responses. The summary of respondents results on willingness to continue using AEOLIX is presented in figure below:

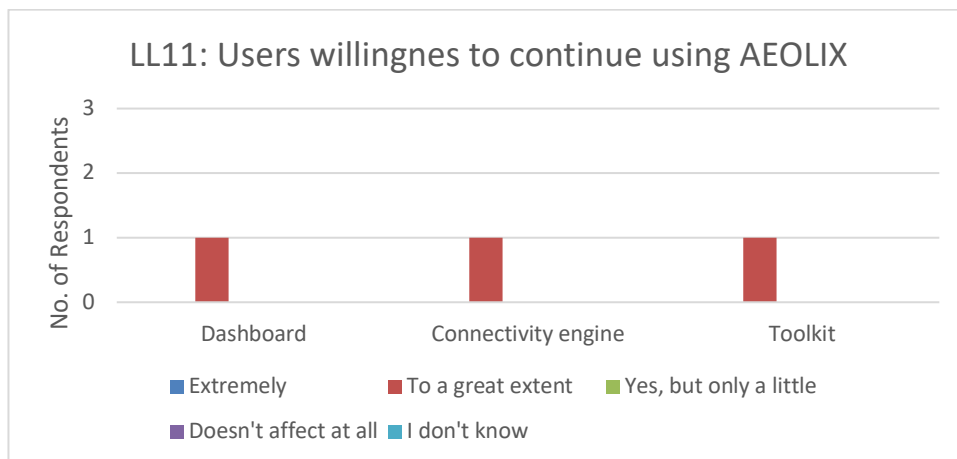


Figure 168: USers willingness to continue using AEOLIX at LL11

After willingness to continue using AEOLIX, we asked question about trust on various components: ***To what extent, users trust on various AEOLIX functions?***

The results show that users at LL11 trust on all three functions to a great extent. This trust has emerged from AEOLIX usefulness and meeting the performance expectancy. A summary of users trust on various AEOLIX functions is presented in Figure 169 below:

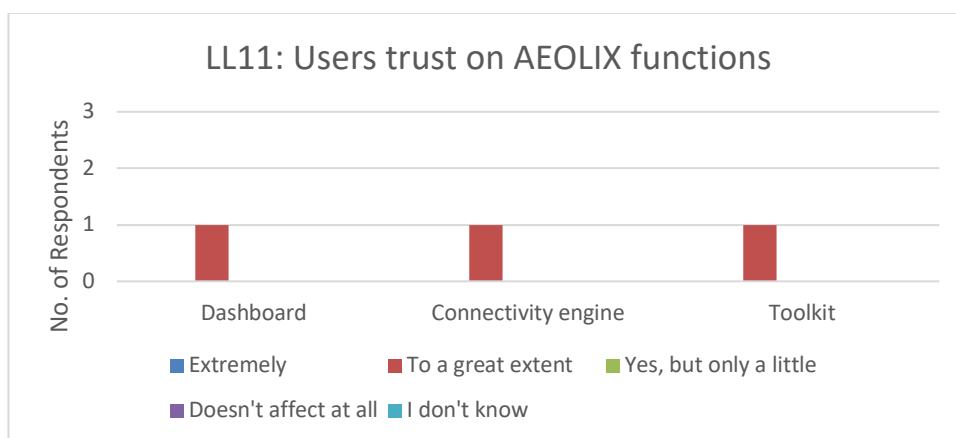


Figure 169: Users trust on AEOLIX at LL11

This study further investigated number of aspects related to AEOLIX acceptance. The results are presented in the Figure 170 below:

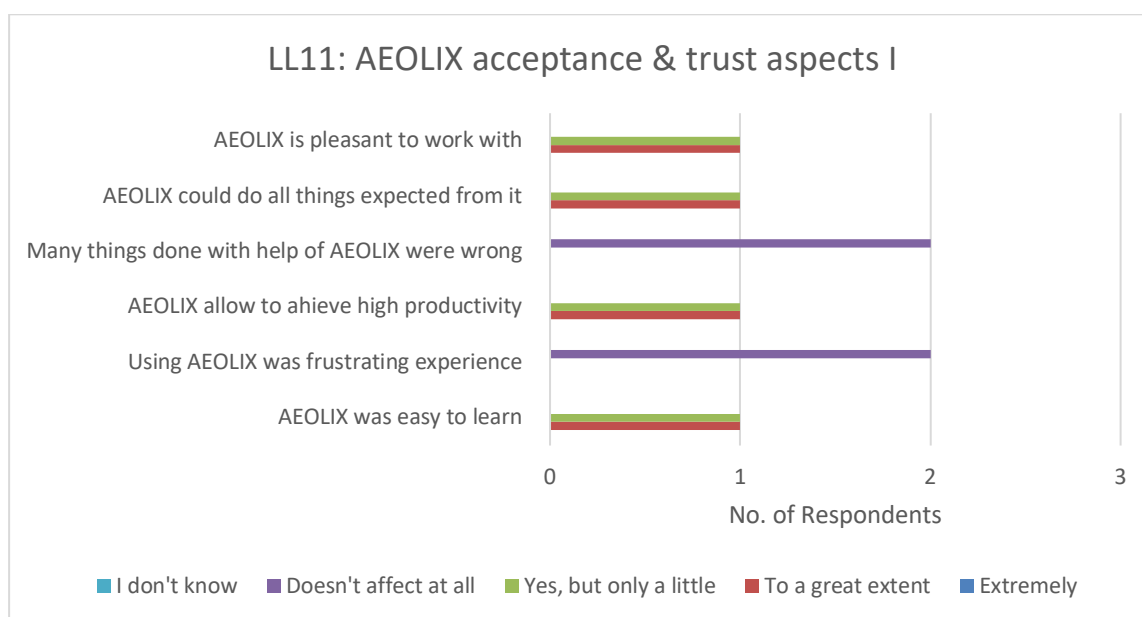


Figure 170: AEOLIX acceptance & trust aspects-I at LL11

The results for LL11 depict that four out of six aspects related to AEOLIX acceptance and trust have equally graded split views by the respondents. These aspects include AEOLIX is pleasant to work with; AEOLIX could do all things expected from it; AEOLIX allow to achieve high productivity; and easy of learning AEOLIX. The split lies between AEOLIX impacting these 'to a great extent' or 'only to a little extent'. However, two of the aspects were not impacted by AEOLIX at all. These two aspects are using AEOLIX as a frustrating experience or things done with AEOLIX proven wrong. Based on these aspects

it can be said that AEOLIX has medium to low acceptance and trust level. Last but not the least, we probed into further aspects related to AEOLIX acceptance and trust as shown in the Figure 171 below:

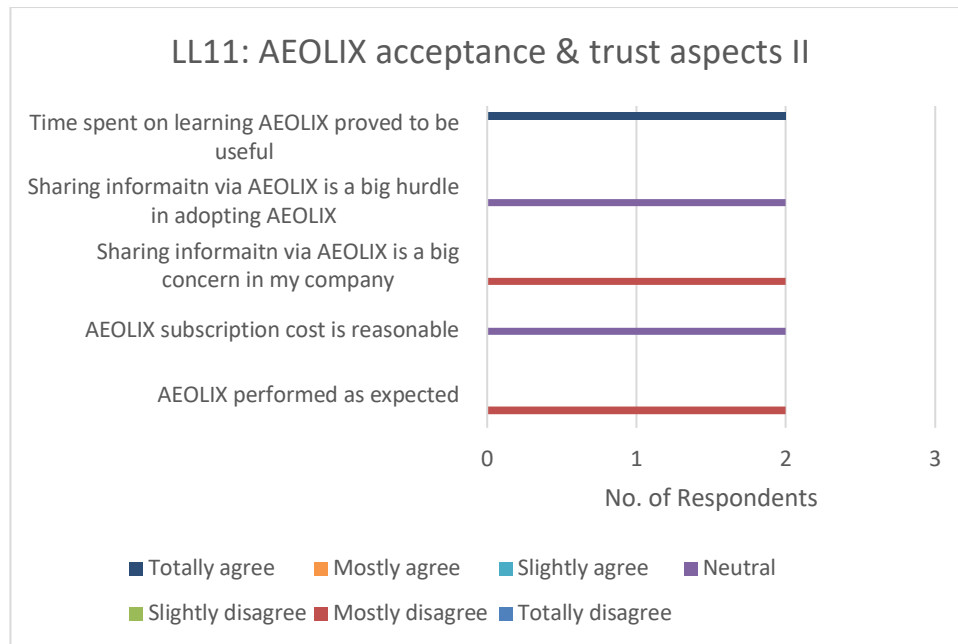


Figure 171: AEOLIX acceptance & trust aspects-II at LL11

All respondents 'totally agree' to the claim that AEOLIX proved to be useful for LL11. However, the respondents have neutral views about sharing information via AEOLIX as a big hurdle in adoption of AEOLIX and AEOLIX subscription cost being reasonable. This can have negative impacts for LL11 trying to accept and adopt AEOLIX system. However, respondents do not see sharing information via AEOLIX raising serious concerns among employees at their companies within the living lab.

5.1. LL12 Operational Impacts Assessment

Living Lab 12 (LL12) is a type of living lab with a focus on supply chain digitalization through digital CMR note. LL 12 will showcase the potential of digitalization in transport and its contribution in increasing the visibility across the supply chain of national and cross-border operations across Europe through the use of digital freight transport documents.

LL12 focuses on several corridors in Europe which, from recent AEOLIX investigations, have resulted as network-wise critical for freight transport operations in Europe in order to address the greater scope of digital freight transport documents. In freight transportation, going digital offers a largely unexplored potential for decreasing operational and administrative costs and errors, and enforcing legislation in an efficient way. LL12 has explored and piloted the use of electronic freight transport documents focusing on e-CMR, and the multi-faceted benefits entailed therein. As electronic freight transport documents are not accepted by all involved stakeholders and entities in the supply chain, paper documents are still dominant in freight transport operations. LL12 has raised the awareness on the current barriers and has deployed activities to support the acceptance and the use of electronic freight transport documents through its testing across 4 European corridors in 5 countries (Czech Republic, Germany, Greece, Romania and Republic of Serbia).

The AEOLIX platform is crucial for addressing these needs and the achievement of these objectives. It is through AEOLIX that the involved entities will gain visibility and will be able to share and access business related data and information in a secure way in a trusted environment. AEOLIX will act as the enabler of this information transaction and will facilitate the access of the related entities to it. As with all data that will be handled in AEOLIX, the ownership remains with the entities involved and not with the platform. The same will go for the e-CMR service. The e-CMR service that will be used in LL12 will be offered through the AEOLIX toolkit where approx. 100 freight transport operations are envisaged to be conducted for each respective corridor (totally 400) involving the consignor (shipper, freight forwarder), the carrier (transport operator) and the consignee. Some of the long-term benefits include:

- Significant reduction of administration work due to reduced data entry, no paper handling, no fax/letter/scan exchanges, no archiving, faster invoicing, real-time access to information and to proof of pick-up and delivery. Expected reduction: 3 to 4 times less effort to be evaluated in temporal and monetary KPIs.
- Reduced inspection time due to faster access to information, faster back-end research and cross-check on behalf of road authorities. Expected reduction: up to 7% less time on the overall transport (from pick-up to delivery and finally to invoicing) – be evaluated in digital vs. paper-based operations during LL operations.
- Environmental friendlier operations due to less sheets of paper issued and carried. Expected reduction: only regarding vehicles transport, 135 tons of wood are used for the paper documents carried. Results to be extrapolated in other business sectors based on LL operations.

LL12 has 15 managers from different companies responding to the survey. The size of the company varies in terms of number of employees ranging from as low as 30 employees to as high as 12000 employees. Following Figure 172 shows number of employees in each company:

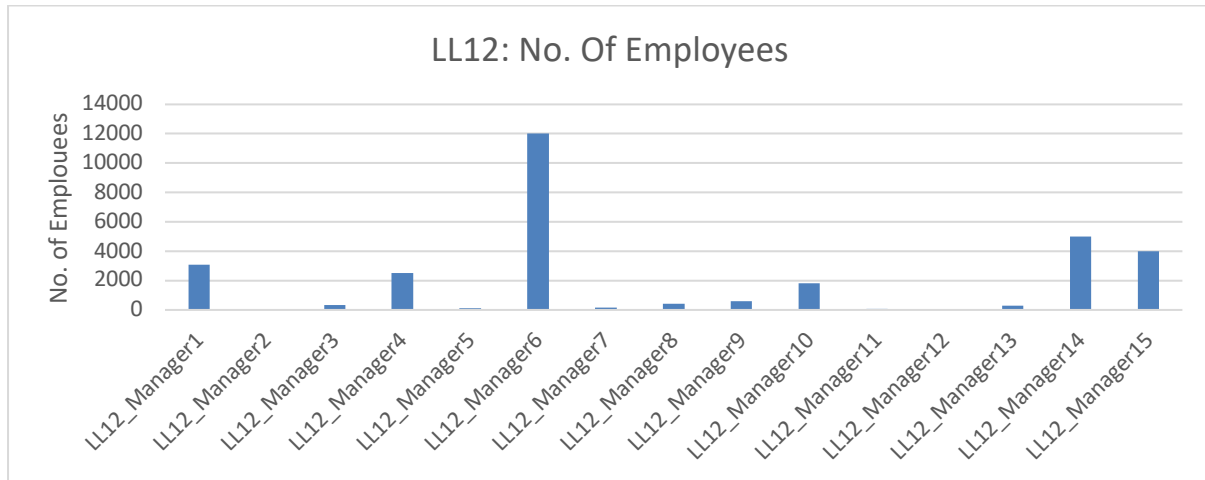


Figure 172: Number of employees at respondents companies within LL12

These employees have a considerable amount of experience. Only 3 managers have 4-5 years and other 3 have 5-6 years of experience. Rest of the 8 respondents have more than 6 years of experience. Therefore, the responses from these experts have high value in terms of insightful information.

All of these companies play different roles in supply chain including the following:

- Forwarder / logistics service provider / logistic operator
- Hub/Terminal Operator
- Hauliers / Carrier / cargo operator
- Shipper / manufacturer
- Custom operator / rail operator / infrastructure operator / fleet and transport operator / vessel operator
- Shipper customer / consignee
- Retail and warehouse

These companies also vary in terms of number of vehicles owned by the company. The number of owned vehicles ranges from 25 to 1500. This means that LL12 has implemented AEOLIX solution of e-CMR in various sizes of businesses. Furthermore, these companies also have partnerships with external parties who own and operate additional vehicles. The type of vehicle that has been used in most cases is the truck.

In terms of areas served, companies within LL12 served both urban and rural areas at domestic and international levels. The following Table 42 shows the number of companies serving each distinct area (this should be noted that many companies serve more than one areas):

Table 42: Distribution of areas served by respondent companies within LL12

<i>Area Type / Level</i>	<i>Domestic</i>	<i>International</i>
Rural	11 companies	9 companies
Urban	11 companies	8 companies

These vehicles are used to deliver various types of groups of products or goods. Some of the goods are distributed by multiple companies. The types of groups for products or goods include:

- Products of agriculture, hunting, and forestry; fish and other fishing products
- Food products, beverages and tobacco
- Textile and textile products; leather and leather products
- Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media
- Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
- Other non-metallic mineral products
- Basic metals; fabricated metal products, except machinery and equipment
- Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
- Transport equipment
- Furniture; other manufacturing goods n.e.c.
- Secondary raw material; municipal wastes and other wastes
- Mail, parcels
- Equipment and material utilized in the transport of goods
- Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods n.e.c.
- Grouped goods: a mixture of types of goods which are transported together
- Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16
- Other goods

These goods have been transported using different forms of road, rail or sea freight transportation modes. The road transportation modes include:

- Solid bulk goods
- Large freight containers
- Other freight containers
- Palletized goods
- Pre-slung goods
- Mobile, self-propelled units
- Other mobile units
- Other cargo units not specified elsewhere

The sear freight mode of transportation includes the following:

- Dry bulk
- Containers
- Ro-Ro units (wheeled vehicles that can be loaded and discharged without cranes)
- Other cargo

To meet different goals set for LL12, AEOLIX solution has been implemented that helped to save time and reduce costs in various areas. The reduction in these areas is measured in the form of KPIs including the followings:

- Average waiting time
- Administration work
- Level of service
- Visibility / data sharing
- Interoperability
- Financial benefits
- Acceptance and trust

These KPIs impact on various aspects at LL12 operational level. For example, average waiting time helps in reducing noise pollution and improving quality of life. Similarly, reduced operational cost is affected by waiting time of trucks at the terminal, time spent on administrative work, and financial benefits brought with the use of AEOLIX. Job creation is directly impacted by level of services users obtained within their logistics and supply chain business. Finally, SMEs empowerment is impacted by waiting time of trucks at terminal, time spent on administrative work, financial benefits as well as acceptance and trust level of AEOLIX. A summary of KPIs impacting on these various aspects is shown in Figure 173 below.

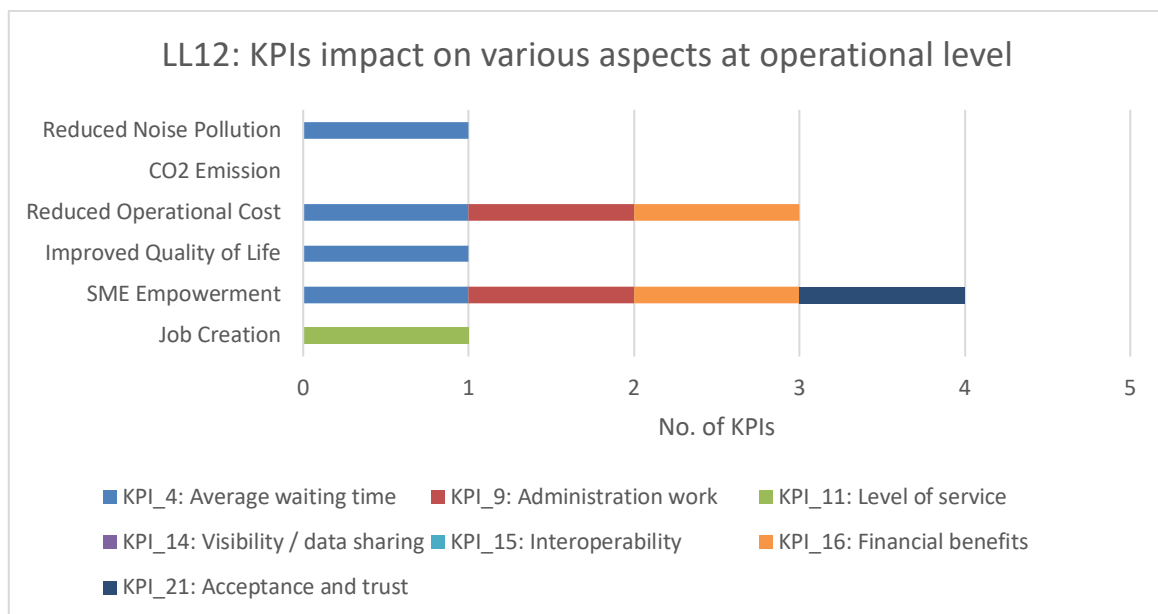


Figure 173: KPIs impact on various aspects at LL12

5.12.1. LL12 Business Aspects – Reduced Operational Costs

LL12 was a special living lab that was established during the course of the project as a part of supply chain visibility and vertical control and network optimization category. Therefore, the number of benefits brought by AEOLIX are limited in numbers. However, these benefits have brought a considerable amount of financial benefits for LL12 as shown in Table 43 below.

Table 43: Summary of KPIs benefits at LL12 (before & after AEOLIX)

Business impacts LL12	Min Target Value	Before AEOLIX	After AEOLIX	Achieved / Estimated Value %	Impact conclusion
Reduction in fuel consumption (l/km; km/l; or l/tkm)	25-30%	LL12 has been categorized in Supply chain visibility and vertical control and Network optimization categories in the revised 2.5 deliverable (included in D5.8 for LL12). Because we have to do with a digital document, reduction in consumption, decrease of empty runs etc. cannot be impacted directly. In case we want to measure other KPIs, such as faster payment procedures etc. that would be possible.			
Increase in consolidated trips (#)	25-35%				
Decrease in % of empty runs ()	25-40%				
Increase of % of load factor (CBM or weight)	35-40%				
Reduction of waiting time for trucks in the terminal (hrs)	n/a	89	22,6	-74,61%	75% reduction of truck waiting time at terminal.
Administration work (minutes/hrs)		89	22,6	-74,61%	75% reduction of time

This is clear from the table that the use of e-CMR brought benefits on administrative work and by reducing waiting time for truck in the terminal. However, this reduction involves a number of reductions in time including creation of e-CMR, average waiting time, average time for signature process, average time spent on road inspection, and average time spent in administration work. The waiting time for the creation of an e-CMR was reduced by 74.6%. Average time for signature processing was reduced by 76.3%. The average time on road inspection was reduced by 62.2% and the average time in administrative paper work is reduced by 83.8%. In total, the waiting time for trucks at the terminal was reduced by 74.6%. The difference in target value and achieved or estimated value is shown in Figure 174 below:

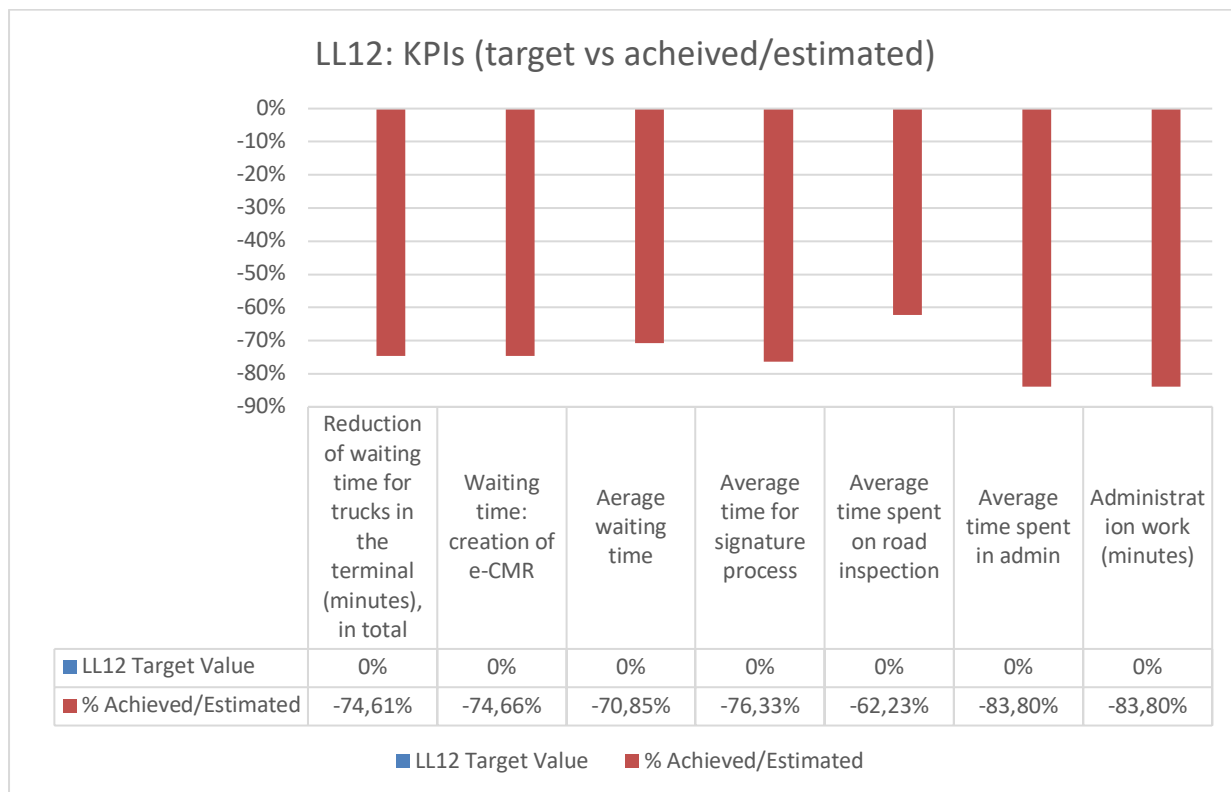


Figure 174: Summary of KPIs benefits in % at LL12 (target vs actual)

Reduction of waiting time for Trucks at Terminal

In total, average waiting time for trucks at terminals is reduced from 89 minutes to 22.6 minutes bringing in the benefit of 74.61%. The values showing this reduction in minutes, before and after AEOLIX, are shown in Figure 175 below.

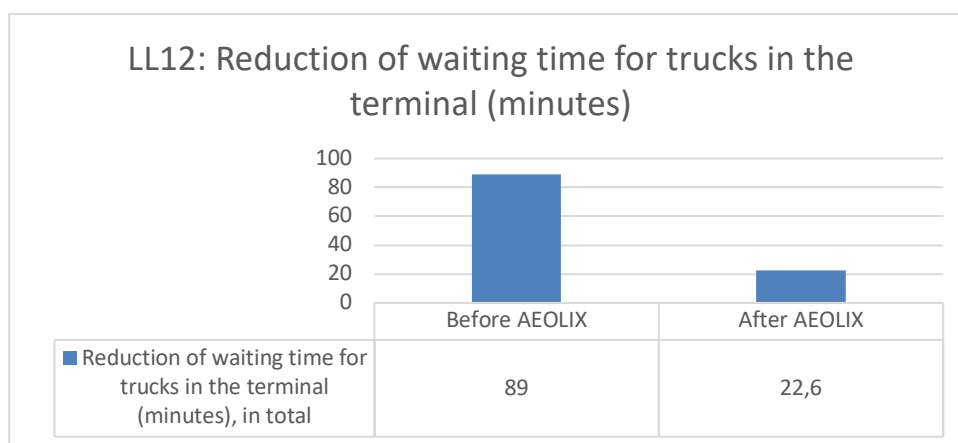


Figure 175: Waiting time for truck at LL12 (before & after AEOLIX)

This time is an average of multiple times associated with trucks waiting time at the terminal. The breakdown of this waiting time, in minutes, is shown in Figure 176 below:

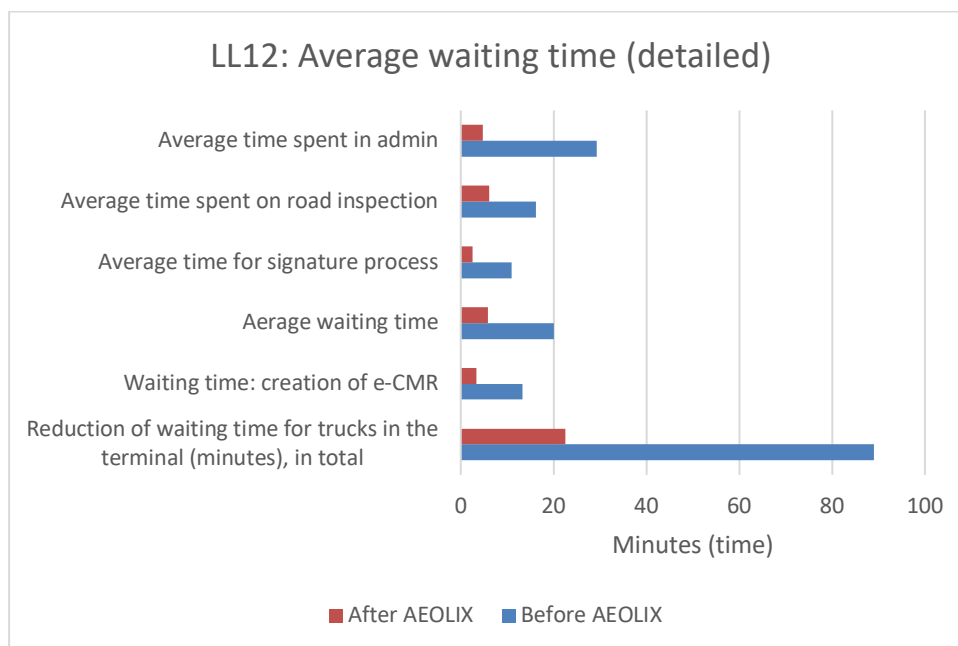


Figure 176: Average waiting time in details at LL12 (before & after AEOLIX)

Administration Work

The time specifically spent on administration work is reduced from 29.33 minutes to 4.75 minutes as shown in Figure 177 below. This amounts to 83.8% reduction in the time required by administrative processes at LL12. This reduction is mainly due to the use of electronic document called e-CMR which replaces traditional paper work. This also removes or reduces unnecessary waiting times, for example, for signing the documents as well as sending automatic report for shipments. All of the AEOLIX functions as well as e-CMIR are considered helpful to an 'extreme' or 'to a great' extent.

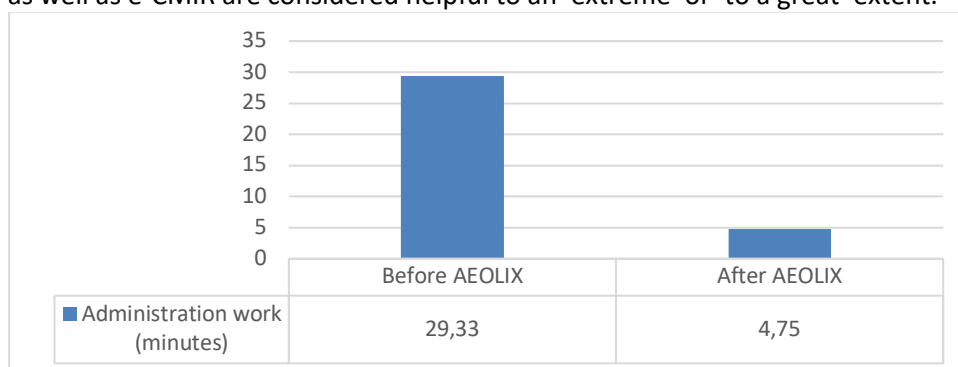


Figure 177: Administrative work benefits at LL12 (before & after AEOLIX)

AEOLIX impact on reducing operational cost (time)

All the reductions in values of KPIs are useless if they fail to bring financial or economic benefits to living labs. LL12 has saved two major costs related to logistics management as well as loss, damage and claims.

Logistics management include costs are achieved through trade management and has a target value of 5.5-6%. AEOLIX was able to help LL12 by saving costs for administrative tasks regarding e-CMR (time in minutes spent per e-CMR). The cost is reduced by 83% which is a big achievement as compared to the lower limit of set value of set value of 5.5%. Similarly, the costs related to loss, damage and delay are related to reduced delays and claims costs. The target for this type of cost was set to the range of 1-3%. AEOLIX has again outperformed by potentially saving costs by 66%. Main part of the cost is achieved through processing of transportation documents. All four AEOLIX functions have been useful in reducing costs to a greater extent, in general. A summary is presented in Figure 178 below:

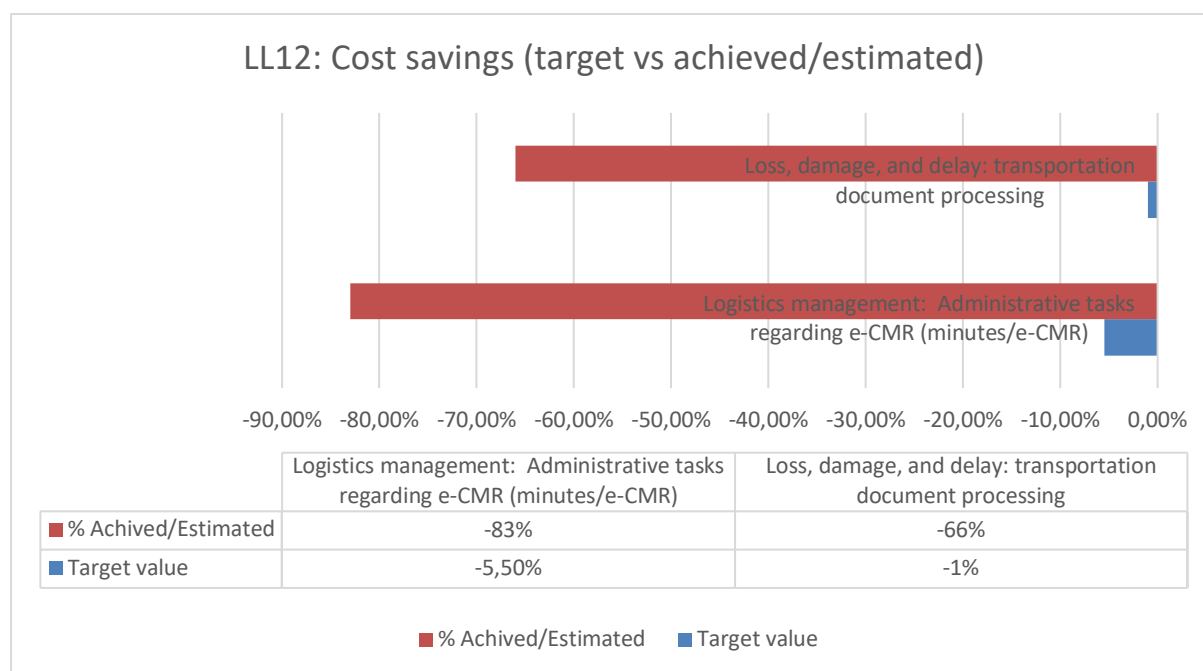


Figure 178: Cost savings at LL12 (target vs achieved)

5.12.2. LL12 Environmental Aspects

Reduced CO₂ Emissions

No data available as reduction in average CO₂ emission was not the direct target for LL12.

Reduced Noise Pollution

Since AEOLIX has not been implemented in vehicles in the real-time within LL12, therefore noise pollution for operational level staff was not affected much. The respondents or users who have benefited from the use of AEOLIX are related to administrative work. All four AEOLIX functions namely Dashboard, connectivity engine, toolkit services, and authentication services were able to help reducing noise pollution 'but only to a little' extent. Only one function of e-CMR was able to help in reducing noise pollution to a great extent or even has been extremely helpful, in some cases. A summary of results is presented in Figure 179 below:

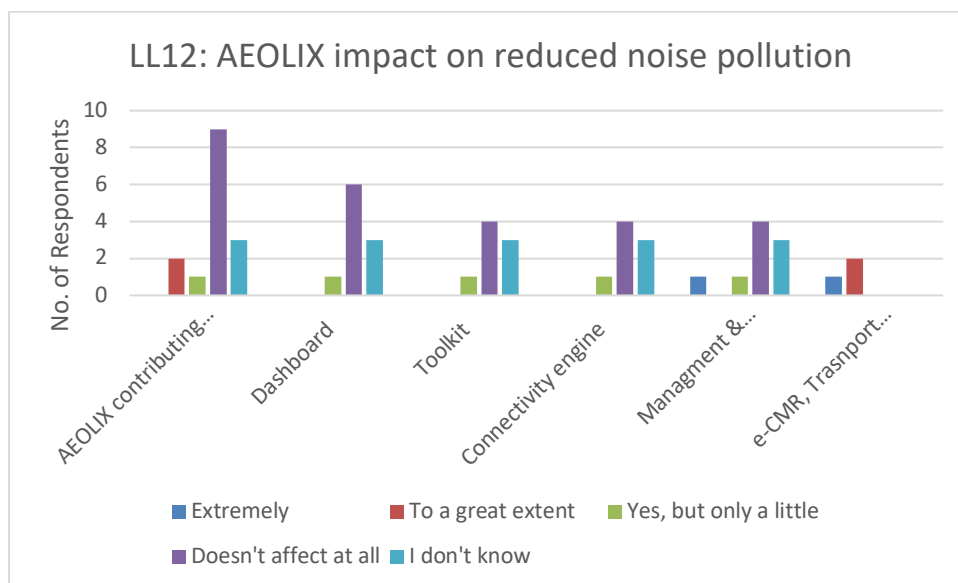


Figure 179: AEOLIX impact on reduced noise pollution at LL12

5.12.3. LL12 Socio-economic Aspects

In addition to reduced operational costs and environmental benefits, socio-economic aspects have been considered important. The socio-economic aspects include job creation, SMEs empowerment, and improved quality of life. A description of each is presented in the following sections.

Job Creation

AEOLIX was conceived to have impact on creating new jobs for companies within LL12. For this purpose, the study asked questions regarding number of drivers and operators' jobs. For operators' jobs, 8 out of 15 respondents think that AEOLIX will not impact on jobs creation while other 3 are not sure if it will have any impact. However, two of the respondents think that AEOLIX will be able to create 1-2 jobs per year. Similarly, 8 respondents did not see any impact where AEOLIX is leading to new driver jobs and other 3 are unaware of the AEOLIX impact on jobs creation. Finally, one person think that AEOLIX will be helpful to crate 1-2 jobs per year and the last one thinks that it will be able to create even 3-4 jobs per year. A summary of responses is shown in the Figure 180 below.

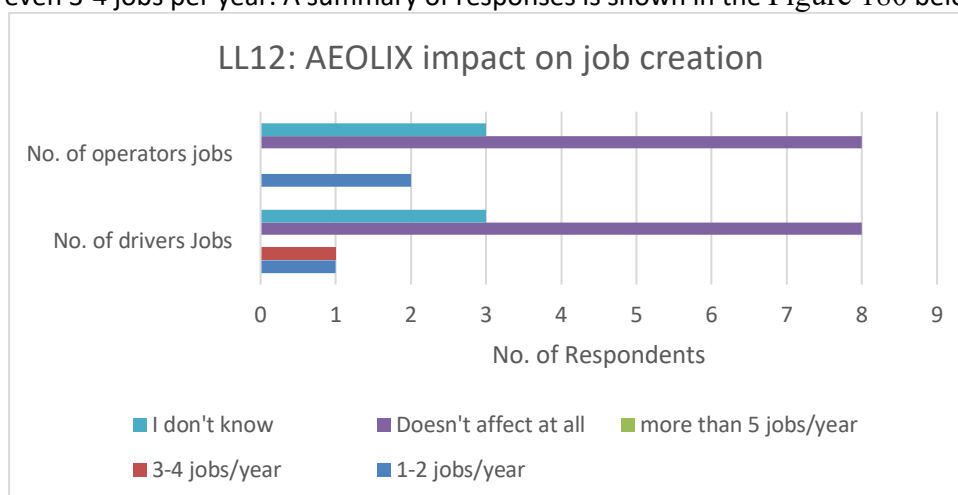


Figure 180: AEOLIX impact on job creation at LL12

SMEs Empowerment

SMEs empowerment includes (i) increased collaboration with large organizations; and (ii) an increase in the market share. Both the aspects have split views from all 15 respondents. For increase in market share, 6 people think that AEOLIX doesn't help SMEs gain more financial benefits from the market. While other 3 are unsure if it will bring any benefits, in terms of an increase in market share. Only 2 out of 15 think that AEOLIX will help to gain market share but 'only to a little' extent. Finally, 20% of the respondents think that AEOLIX will help SMEs to gain more financial benefits by increasing market share.

Similarly, 40% (6 out of 15) respondents think that AEOLIX has not been helpful to SMEs in developing an increased collaboration with large organizations. Another 30% are unsure about AEOLIX contribution in increasing collaboration. However, 3 respondents think that AEOLIX will help in increased collaboration 'but only to a little extent' and another 2 think that it will help 'to a great' extent. Finally, one person is quite optimistic and think that AEOLIX will be extremely helpful for SMEs in increasing collaborations with large organizations. A summary is presented in Figure 181 below:

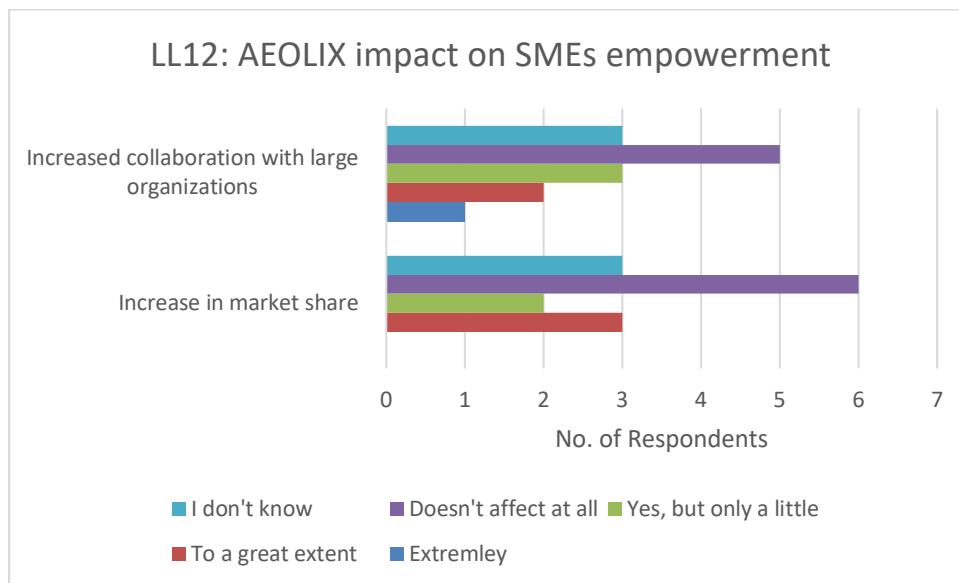


Figure 181: AEOLIX impact on SMEs empowerment at LL12

Improved Quality of Life

Another important sub-aspect related to AEOLIX impact on socio-economic aspects is known as improved quality of life. This study probed into a number of issue associated with AEOLIX improving quality of life for employees at LL12 as shown in Figure 182 below. The first aspect is related to if AEOLIX can help employees to put more focus on work. The results show that 40% (6 out of 15) have the opinion that AEOLIX have not helped employees to put more focus on work. Furthermore, more than 25% (4) of respondents think that it helped employees to put more focus on work 'but only a little'. Almost 15% think that it helps employees to put more focus on work 'to a great extent' while only less than 10% think that AEOLIX can 'extremely' help employees to put more focus on work. AEOLIX helping employees at companies within LL12 to reduce stress at work has split views. Only one third of respondents think that AEOLIX help reducing stress at work, but only to a little extent.

Less than 10% think that AEOLIX can help ‘to a greater extent’ while another 15% think that it can fully help employees to reduce stress. Finally, rest of the respondents are either unaware of the AEOLIX impact on reducing stress level or have the opinion that AEOLIX does not help employees in reducing stress level, at all.

Similarly, only one fifth of the respondents think that AEOLIX helps employees (using AEOLIX) to be recognized at work, and their colleagues have more positive attitude towards them. Only about 15%, in total, think that AEOLIX will help to a great extent or have the full potential in changing people attitude towards their employees or colleagues. The rest of respondents either do not have any opinion about such kind of AEOLIX impact or share the view that AEOLIX could help in changing people attitude towards those using AEOLIX.

Finally, the results show that AEOLIX does not provide any reward (almost 25%) or provides only to a little extent. Only 15%, in total, share the view that AEOLIX can be beneficial to a greater extent or extremely important in providing rewards to employees associated with LL12. A summary of these responses is shown in figure below.

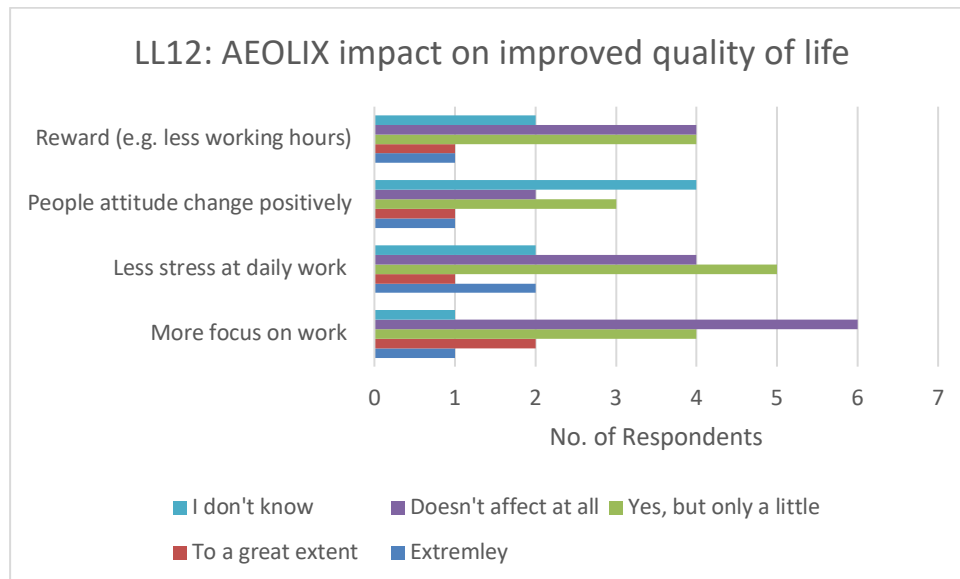


Figure 182: AEOLIX impact on improved quality of life at LL12

5.12.4. AEOLIX Acceptance and Trust at LL12

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. Following figures shows how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance. The analysis show that LL12 evaluation manager thinks that AEOLIX use is directly related to the degree of approval by users but only to a little extent. However, change in AEOLIX acceptance and trust level impact improved planning and overall performance, increased responsiveness, improved efficiency of operations, and relationship with users ‘to a great’ extent. A summary of these impacts are presented in Figure 183 below:

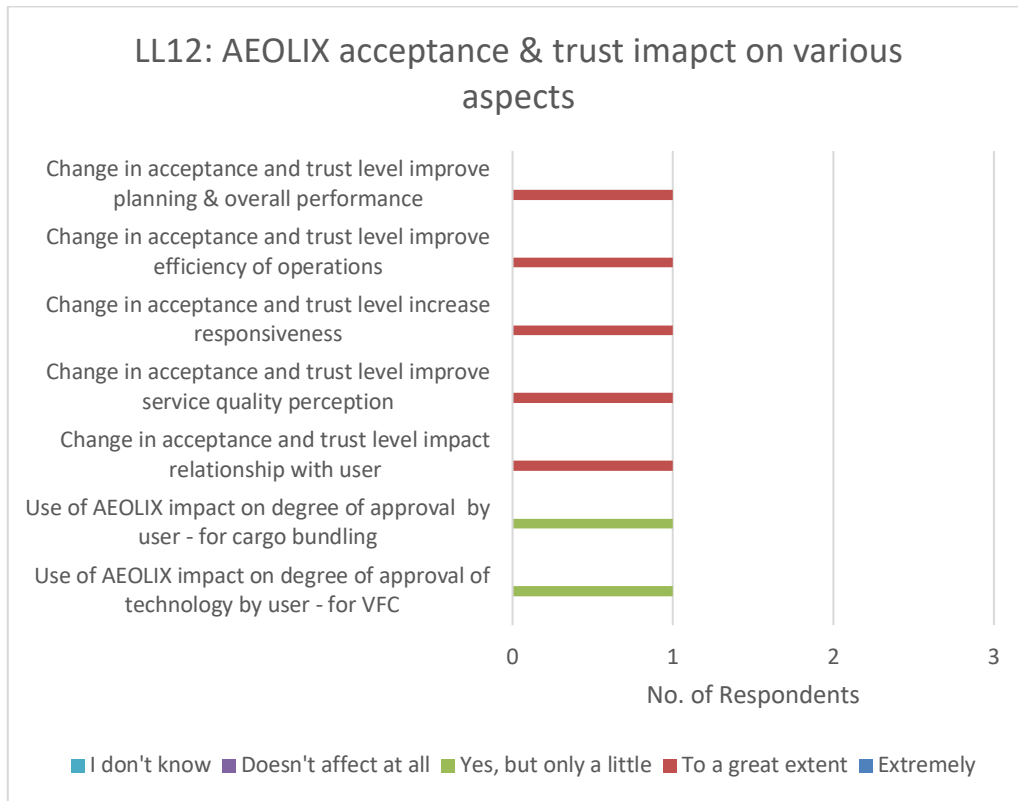


Figure 183: AEOLIX acceptance & trust impacts on various aspects at LL12

The study further asked question: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 184 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by LL12 evaluation manager.

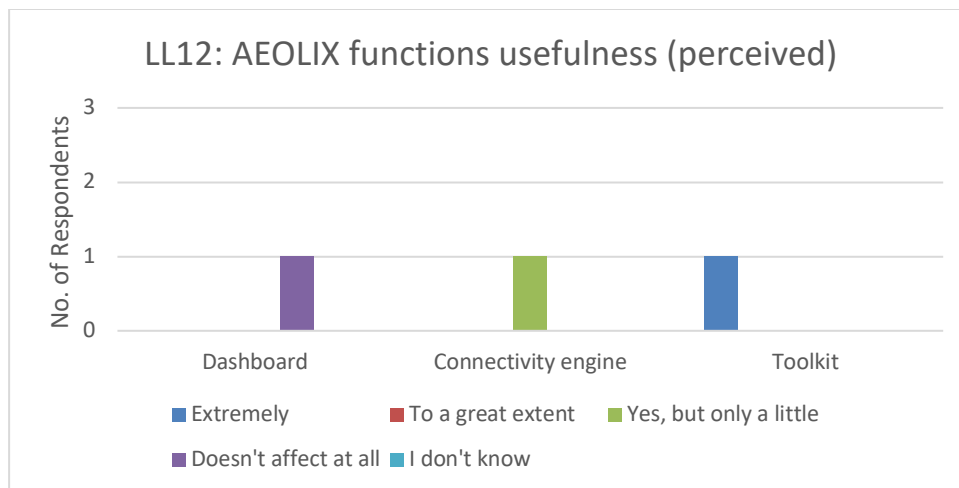


Figure 184: AEOLIX functions usefulness at LL12 (perception)

The analysis of the results show that only toolkit services were perceived to be extremely useful. However, the function was proved to be useful to a great extent which is a little less than its performance expectancy. On the other hand, connectivity engine was perceived to be useful ‘but only a little’. And the engine has performed exactly as it was perceived. Finally, Dashboard was not applicable to LL12 users. This implies that LL12 evaluation manager was not optimistic about the various functions as the project development moved on and users at LL12 know that this was a research project. The results imply that the acceptance and trust on AEOLIX is moderate, since the usefulness of AEOLIX functions is directly related to the acceptance and trust on the system. A summary of results is presented in Figure 185 below.

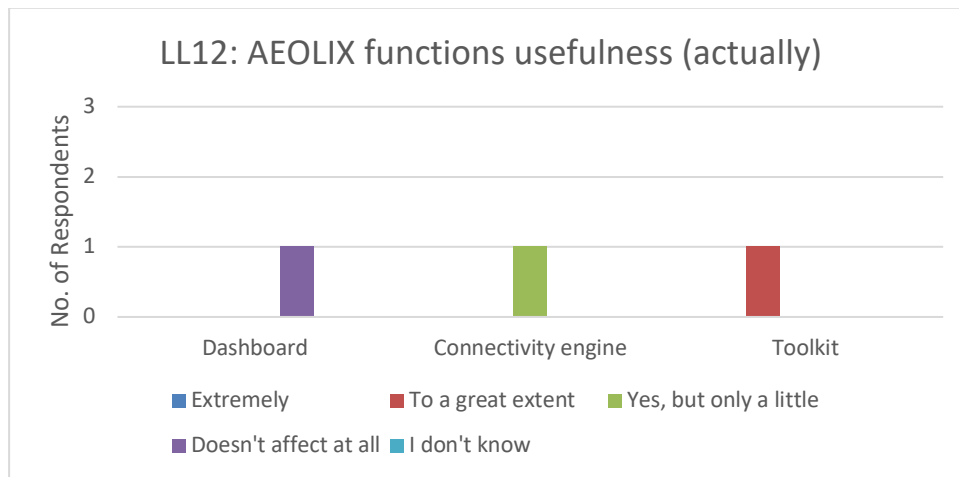


Figure 185: AEOLIX functions usefulness at LL12 (in actual)

This study further probed into what was actually expected of AEOLIX and what users got. For LL12, AEOLIX was perceived as a system for providing faster paperless freight transport assignments and better reallocation of workloads. Managers at companies are satisfied with the AEOLIX meeting their expectations especially with e-CMR.

The study continued to ask questions about users’ willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

The results shows that LL12 evaluation manager is unsure about using Dashboard. Furthermore, the living lab evaluation manager does not know if he or she will be using connectivity engine and toolkit functionalities. The willingness to continue using AEOLIX is directly related to the usefulness. Since the usefulness is not rated high, the willingness to continue using the system follows. The summary of the respondents’ results on willingness to continue using AEOLIX is presented in Figure 186 below:

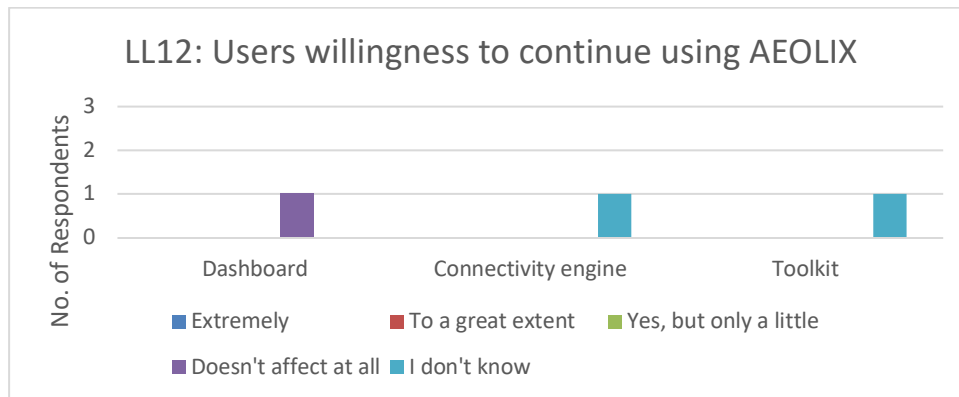


Figure 186: Users willingness to continue using AEOLIX at LL12

After willingness to continue using AEOLIX, this study asked a question on the trust on various components: ***To what extent, users trust the various AEOLIX functions?***

The results show that LL12 evaluation manager trusts 'but only a little' on connectivity engines. However, the manger trust on toolkit functionality 'to a great extent'. On the other hand, Dashboard is not used at all by LL12. This is the result of average or even below average usefulness of AEOLIX as well as the errors and problems occur during the use of the system. A summary of users trust on various AEOLIX functions is presented in Figure 187 below:

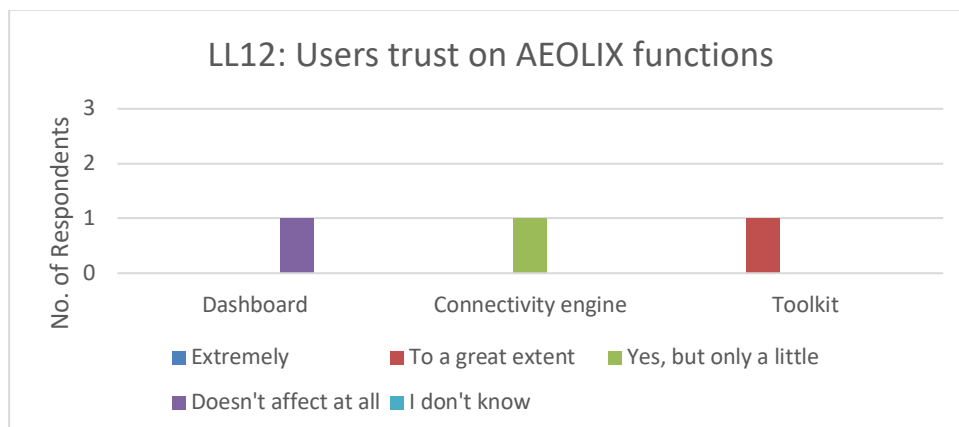


Figure 187: Users trust on AEOLIX functions at LL12

One of the reasons of low trust level is little use of AEOLIX system which is less than 40 hours per month for LL12. The reason for little use is also associated with late development and implementation of the complete AEOLIX system. Again, LL12 does not use Dashboard and is not relevant in this case.

This study further asked questions on the easiness of learning of AEOLIX: ***To what extent, AEOLIX was perceived easy to learn? And to what extent, AEOLIX was actually proven easy to learn?***

The results show that most of the respondents (more than 80%) thought that AEOLIX will be very ('to a great extent') easy to learn. Only one respondent expected more efforts in learning AEOLIX. Furthermore, one respondent expected it to be extremely easy to learn. The results shows that learning AEOLIX proved to be more easy to learn than expected for a number of employees. That is, four of the respondents think that learning AEOLIX was 'extremely' easy while another four responded

that it was still easy to learn 'to a great extent'. A summary of users respondents on expected and actual efforts regarding ease of learning AEOLIX is presented in Figure 188 below:

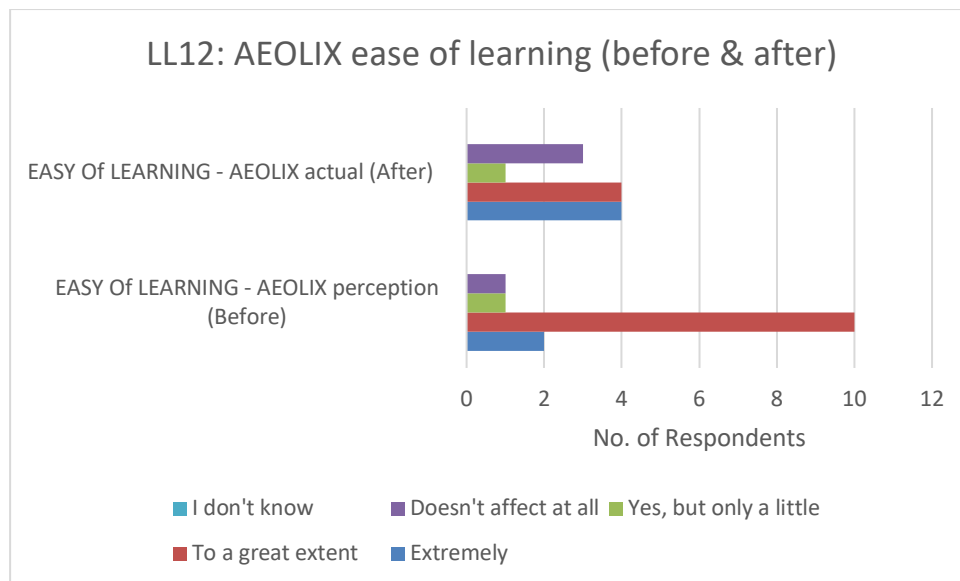


Figure 188: AEOLIX ease of learning (before & after AEOLIX)

This study further investigated number of aspects related to AEOLIX acceptance. The results are presented in Figure 189 below:

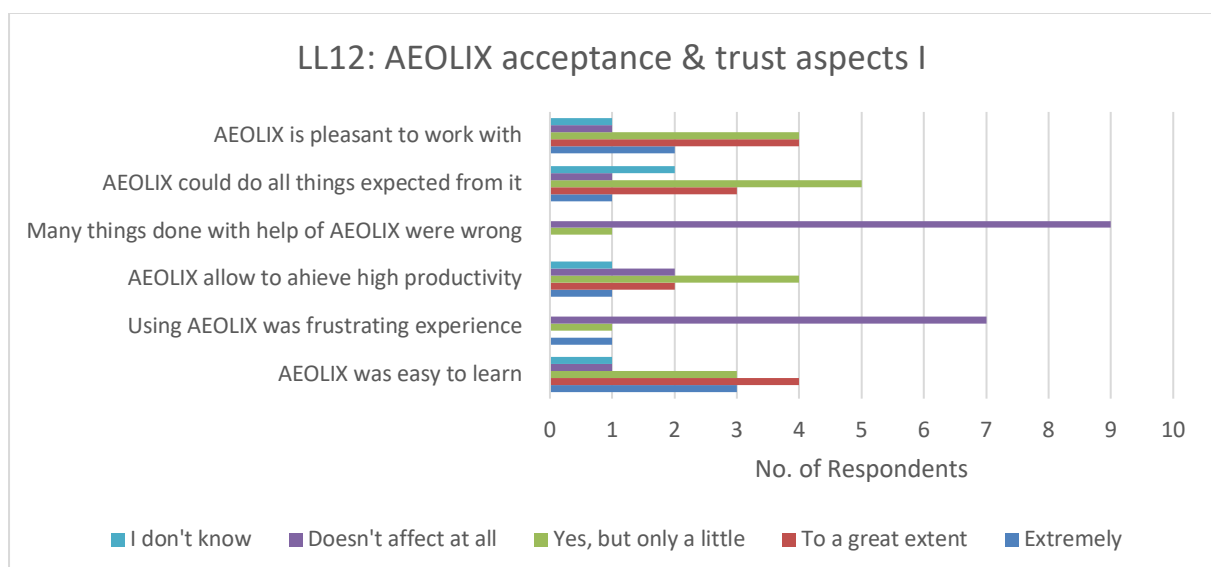


Figure 189: AEOLIX acceptance & trust aspects-I at LL12

The results depict that respondents within LL12 provided variations in their responses for most of the aspects related to acceptance and trust on AEOLIX. However, there are exceptions for two of the aspects 'things done with the help of AEOLIX proven to be wrong' and 'AEOLIX being a frustrating experience'.

experience’. For both of these aspects, majority of respondents neither experienced wrong doing with AEOLIX nor they were frustrated while using AEOLIX.

Further results show that majority of respondents found AEOLIX as either ‘extremely’ (3) or ‘to a great extent’ (4) easy to learn. Only few respondents (3) found it a bit more difficult to learn it. Therefore, AEOLIX easiness of learning can be rated very high. On the other hand, AEOLIX contributing to high productivity got a mixed feedback. One of the respondents found that AEOLIX facilitates ‘extremely’ to achieve high productivity and other two found that it facilitates ‘to a great extent’ in achieving high productivity. However, a considerable number of respondents (4) found AEOLIX being helpful ‘but only a little’ in achieving high productivity. Another two of respondents did not found AEOLIX helpful in achieving high productivity and the last one is unsure about the role of AEOLIX in achieving high productivity.

Similar trend is shown in results related to AEOLIX performing according to its expectations with small variations in numbers. One respondent is ‘extremely’ satisfied with the AEOLIX performance, and another three respondents are satisfied with AEOLIX performance ‘to a great extent’. However, a considerable number of respondents (5) are ‘only a little’ satisfied with the AEOLIX performance meeting their expectations. Rest of the respondents are unsure if AEOLIX really has met their expectations.

Furthermore, majority of respondents had an ‘extreme’ (2) or ‘to a great extent’ (5) pleasant experience while using AEOLIX. However, another five respondents (40%) had ‘only a little’ pleasant experience with AEOLIX. Lastly, rest of the respondents (which is less than 20%) are not sure about their experience being pleasant or not with AEOLIX.

Last but not the least, this study probed into further aspects related to AEOLIX acceptance and trust as shown in the Figure 190 below:

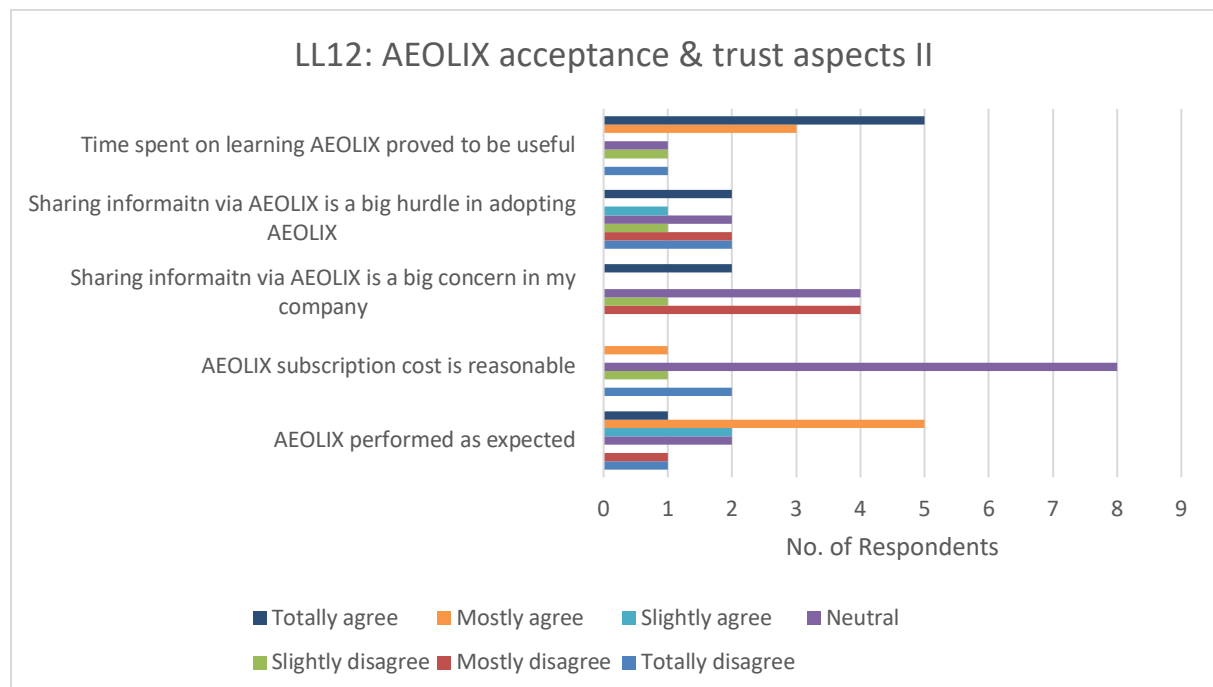


Figure 190: AEOLIX acceptance & trust aspects-II at LL12

Again results show mixed responses by survey participants or respondents on various aspects related to AEOLIX acceptance and trust. These responses not only varies in terms of agreeing or disagreeing but also in terms of the extent of agreeing or disagreeing. A description of these responses for each aspect is presented in following paragraphs.

Overall, respondents rate the ‘usefulness of time spent on learning AEOLIX’ as extremely high. Majority of respondents ‘totally agree’ (5) or ‘mostly agree’ with the claim that the time spent on learning AEOLIX proved to be very useful for them. Only one respondent ‘slight disagree’ and another one ‘totally disagree’ with this claim. One last respondent is ‘neutral’ or is undecided on the time spent on learning AEOLIX was useful.

On the other hand, results on ‘information sharing as a hurdle in AEOLIX adoption’ has more varied results ranging from totally agree to totally disagree. The respondents ‘totally agree’ (2), ‘slightly agree’ (1), ‘slightly disagree’ (1), ‘mostly disagree’ (2), or ‘totally disagree’ (2) with the claim. This means that most only two respondents see information sharing via AEOLIX as a hurdle in adopting it. The rest six respondents have a common view that, though to varying degree, sharing information via AEOLIX is not a hurdle in its adoption. Based on these results, this can be interpreted that sharing information via AEOLIX is suitable while addressing various stakeholders issues such as privacy and data ownership. This is because of the fact that almost one-third of respondents ‘mostly disagree’ and other one-third have ‘neutral view’ on information sharing as a big concern in their companies. This means that majority of respondents are eager to share information via AEOLIX. Finally, majority of respondents have ‘neutral’ view on the claim of ‘subscription cost being reasonable’ for LL12. This is because of the reason that they are waiting for emerging subscription cost model of AEOLIX.

6. Results II – Integrated view on Impacts Assessment

There were a number of alternatives to provide integrated views related to AEOLIX impacts assessment on operational levels. A brief description for these integrated views categories is presented in the following paragraphs.

One way to categorize or classify the living labs according to AEOLIX grant agreement (Part B, page 18). This classification has divided 11 living labs into 3 types: intelligent hubs (LLs 1, 2, 3, 4), multi-synchro modal transport (LLs 5, 6, 7, 8), and network optimization (LLs 9, 10, 11). LL12 have joined later in the project and we have added it to the network optimization type. These categories have been made based on similarities between living labs activities and management needs. Each of the type had defined some target values. These target values are presented in Table 44 below:

Table 44: KPIs target values as set in AEOLIX DoW

KPIs	Intelligent Hubs	Multi Synchro-modal Transport	Network Optimization
	<i>LLs 1, 2, 3, 4</i>	<i>LLs 5, 6, 7, 8</i>	<i>LLs 9, 10, 11, 12</i>
Reduction in fuel consumption	n/a	20-25%	25-30%
Increase in consolidated trips	n/a	25-30%	25-35%
Decrease of empty runs	n/a	5-10%	25-40%
Reduction of waiting time for trucks in the terminal	35-40%	n/a	n/a
Reduction of average loading/unloading time	10-12%	n/a	n/a
Increase of terminal productivity	15-40%	n/a	n/a
Increase of load factor	30-35%	n/a	35-40%

However, it proved to be difficult to provide integrated views with this type of categorization for a number of reasons. First, living labs did not measure all the KPIs for which KPIs targets have been set for them. There are various justifications for not measuring those pre-defined targeted KPIs (see the previous section for further details on justifications). Second, living labs scenarios have changed their characteristics during the project. LL3 is an example where some changes have been made after the amendments. Third, many living labs have measured other KPIs that were not applicable (n/a) to them according to the grant agreement. Finally, a number of living labs do not have access to data or their associated partners were unwilling to share data due to privacy issues and companies' policies. Finally, data analysis shows that every KPI has 3-5 values on average (except fuel consumption). Therefore, dividing 12 living labs into three categories where each category has one or less value is not suitable. Hence, this study did not use this type of categorization for providing an integrated view on category level.

Another way to provide integrated view is to divide all 12 living labs according to their financial benefits. The targeted financial benefits have again been presented in the AEOLIX grant agreement (part B, page 18). These financial benefits from the visibility and monitoring elements of the AEOLIX solution can be measured between 1% and 10% in reduction of costs (McKinney et al., 2015). The financial benefits related to different reductions in cost types is presented in Table 45 below.

Table 45: Cost savings or financial benefits targets as set in AEOLIX DoW

Cost Type	Opportunity
Trade Management labor	5%+ (Trade monitoring)
Logistics management	5.5-6% (Trade management)
Safety Stock	7-9% (Reduction in stock)
Distribution center operations	3-5% (Reduction in facilities and labor)
Loss, damage and delay	1-3% (Reduced delay and claims costs)
Insurance	More than 1% (Reduction in premiums)

This approach also has number of limitations. First, there is no categorization of living labs according to financial benefits. This means that any living lab can achieve one or all the benefits irrespective of its type presented above. Second, not all living labs have provided financial benefit values for all the cost types. Third, not all living labs have provided before and after values of financial benefits. Many of them have provided some estimated amounts. Finally, the analysis of data did not bring about any pattern among living labs financial benefits which can serve as the basis for classification.

The third way to provide the integrated view is to present the results of the analysis across all 12 living labs. This approach for providing an integrated view seems to be the most suitable for this study for number of reasons.

- First, a holistic and comprehensive picture about each KPI can be presented across 12 living labs (see Figure 191 and Figure 192)
- Second, it is easy to describe and compare results for each KPI responses (3-5 living labs reporting values for every KPIs) from 12 living labs.
- Third, this report provides financial benefits in terms of reduced operational costs across 12 living labs due to the low number of responses from each living lab. The same reasons are valid for socio-economic and environmental impacts as well as acceptance and trust on AEOLIX.

Therefore, this study provides descriptions of operational impacts assessments (business, environmental and socio-economic) for 12 living labs in the following sections.

6.1. Overview on measured KPIs

This report starts the integrated view by providing an overall picture of various KPIs measured by different living labs. This is shown in the Figure 191 below. The figure also describes both aspect of measuring KPIs – which KPIs are measured and which are not measured by different living labs. Moreover, the figure shows that how many KPIs a living lab is measuring. Finally, the figure illustrates the number of living labs measuring each KPI and is underlined with a distinct color. For the KPIs which are not measured by a specific living lab these are shown with grey color (right side of figure). For example, LL1 is measuring 11 KPIs including KPI 1 – Reduction in average fuel consumption or simply known as average fuel consumption. The figure also illustrate that KPI 1 – average fuel consumption is being measured by 7 living labs. On the other hand, KPI 2 – Average number of trips with consolidated cargo is not measured by LL1 (the color of line is grey). Similar, descriptions can be made for all living labs as well as for all KPIs. This should be noted that the figure provides an overview to give a sense to the evaluation process, and not all the KPIs mentioned below must be calculated or measure by all living labs. See Table 45 to get a clear picture on which LLs were supposed to measure which KPIs.

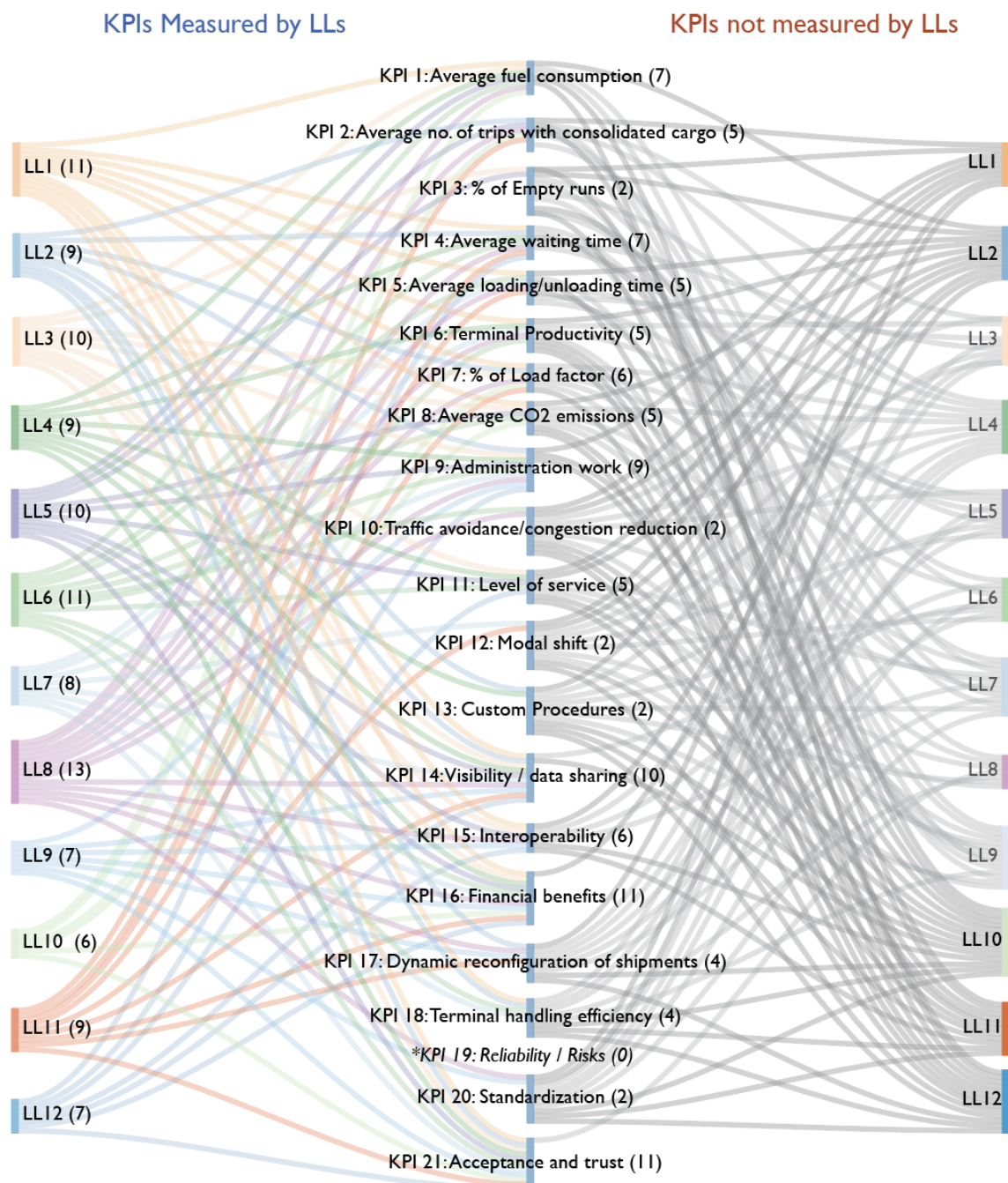


Figure 191: Overview of measured KPIs at each LL (number of lab measurements in parentheses)

In the following section, this report provides a summary of various AEOLIX impacts (business, environmental, and socio-economic) at operational level. These aspects of AEOLIX impacts have further been divided into sub-categories.

6.2. Business Impact Summary

The analysis of the results clearly show that AEOLIX impacts on the businesses of living labs. This impact is mainly seen as reduced operational cost. This report has included the business impacts in terms of (i) reduction in values for KPIs or time; and (ii) cost savings for various types of costs as presented below.

6.2.1. Business Impacts (time/reduction)

The following figure shows the reductions for various KPIs values against the target value sent in AEOLIX grant agreement (Part B, page 18). Every KPI has been assigned a distinct color, and actual value against the target value is presented in the form of bars.

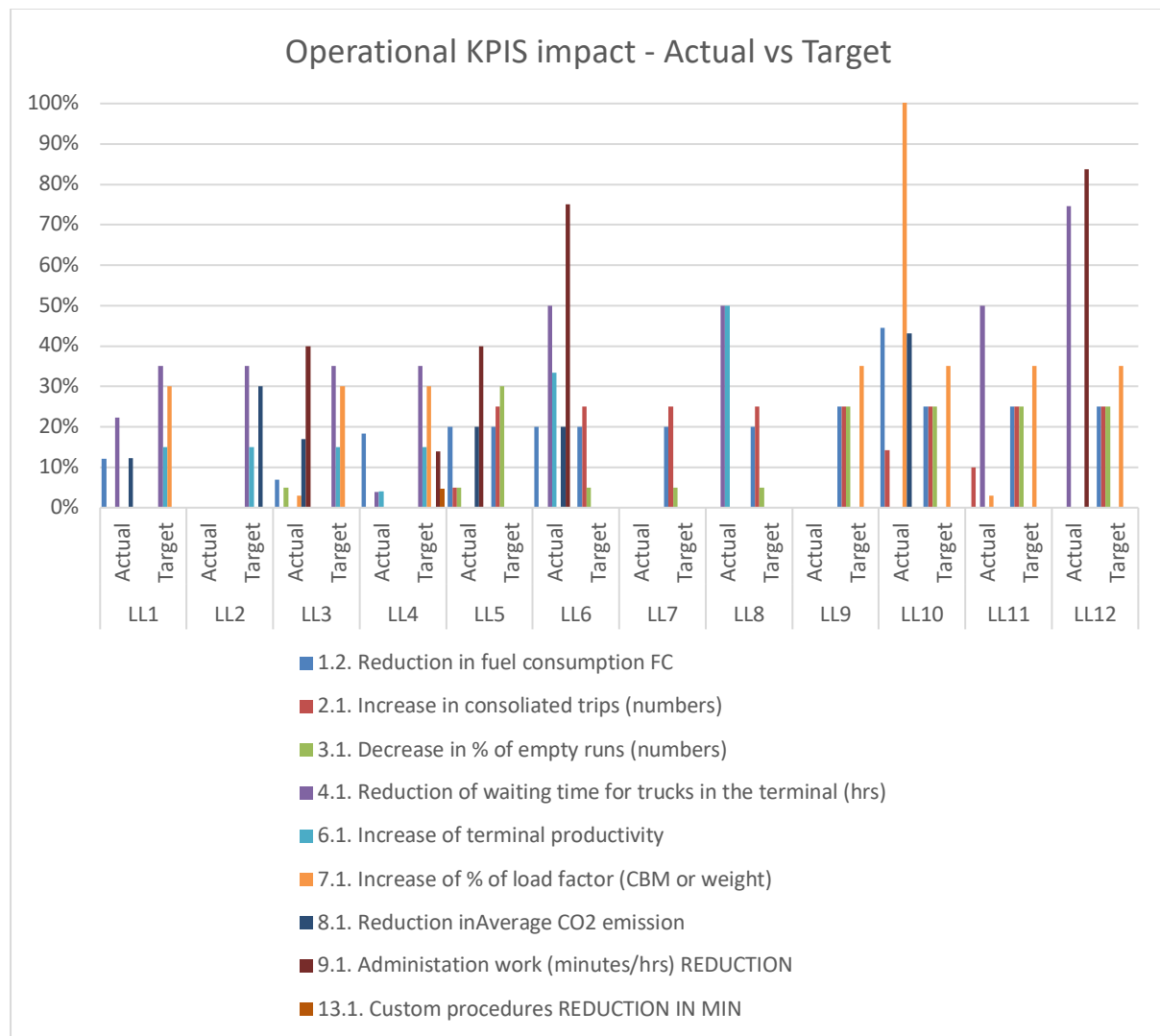


Figure 192: KPIs benefits across 12 living labs (target vs achieved)

Reduction in Fuel Consumption

As mentioned above, two target values ranges were set for fuel consumption at the beginning of AEOLIX project: 20-25% (for multi synchro-modal transport living labs category) and 25-30% (network optimization living labs category). No target was set for intelligent hubs category of living labs. The following Table 46 shows a summary of target versus achieved or estimated values related to reduction in fuel consumption:

Table 46: Summary of reduction in fuel consumption across 12 living labs (target vs actual)

Categories	LLs	Reduction in Fuel Consumption	
		Target Value	Actual Value
Group 1: Intelligent Hubs	LL1	n/a	12.13%
	LL2		n/a
	LL3		6.98%
	LL4		18.38%
Group 2: Multi Synchro-modal Transport	LL5	20-25%	20%
	LL6		20%
	LL7		n/a
	LL8		n/a
Group 3: Network Optimization	LL9	25-30%	n/a
	LL10		44.44%
	LL11		n/a
	LL12		n/a

For the group 1, intelligent hub, no value was set at the beginning of AEOLIX. LL 1 was able to reduce average fuel consumption by 12.13%. If speed and other deviations are taken into account, this value goes down to 14% reduction in fuel consumption. LL2 has not measured it. While LL3 and LL4 were able to reduce the fuel consumption by 6.98% and 18.38% respectively. The LL4 from the intelligent hub group has saved the most fuel and is therefore closest to the lower limit of the set point.

For second group 2, multi-synchro modal transport living labs, the target was set to 20-25%. Two of the living labs, LL5 and LL6, were able to save or have estimated to save 20% on fuel consumption. However, LL7 and LL8 did not provide data on fuel consumption. LL7 has implemented AEOLIX in trains so far. The impacts of AEOLIX on truck fuel consumption is yet to be explored for LL7. Therefore, we can say that two living labs from the second group has achieved target of fuel consumption.

For group 3, network optimization, a target value of 25-30% was set related to reduction in average fuel consumption. The results show that LL10 is the only one that measures this KPI with . LL10 has also achieved 44.44% less fuel consumption, which is highest not only in this type of living lab, but in all 12 living labs. LL9 has implemented AEOLIX in rail transport. Finally, LL12 focused mainly on the use of e-CMR to save hours in waiting times and administrative processes.

The Table 46 above (operational KPIs impact) shows that some living labs changed the KPIs measurement which led to inconsistency on the KPIs results. This shows that these living labs didn't have a clear strategy and objectives in regards to the pilot projects they were running or there was a change in their strategic objectives which affected the performance measurements. In addition, the table below shows that AEOLIX enabled the reduction of fuel consumption due to cargo consolidation but also the increase of load factor and the overall reduction of CO2 emissions due to decrease in the number of empty runs and trips. Furthermore, some living labs showed positive impact in reducing the administration time due to digitalization in documentation which also increased the overall productivity.

Increase in Consolidated Trips

Following Table 47 shows a summary of actual versus achieved or estimated values for increase in consolidated trips:

Table 47: Summary of increase in consolidation across 12 living labs (target vs actual)

Categories	LLs	Increase in Consolidated Trips	
		Target Value	Actual Value
Group1: Intelligent Hubs	LL1	n/a	n/a
	LL2		
	LL3		
	LL4		
Group2: Multi Synchro-modal Transport	LL5	25-30%	5.00%
	LL6		Data not available from partners
	LL7		n/a
	LL8		n/a
Group3: Network Optimization	LL9	25-35%	n/a
	LL10		14.29%
	LL11		10.00%
	LL12		n/a

For group 1, intelligent hub, no value was set for increase in number of consolidated trips and no one has measured the related KPI.

The target value for group 2, multi-synchro modal transport living labs, was set to 25-30% for increase in number of consolidated trips. The analysis of results shows that only LL5 was able to measure the KPI but only with an value of 5% increase in consolidated trips. LL7 has used rail services which is always consolidated, therefore this KPIs is not applicable to LL7. While LL6 was unable to get such information from their partners.

The target value for group 3, network optimization, was set to 25-35% for increase in the number of consolidated trips. However, only two living labs – LL 10 and LL11, were able to measure it with achieved or estimated values of 14.29% and 10% only. These living labs still got benefits with these lesser than target value achievements. LL9 has rail service which is already consolidated and LL12 mainly focused on the use of e-CMR for saving hours in waiting time and administrative processes.

Decrease in % of Empty Runs

Following Table 48 summarizes target versus actual values related to decrease in percentage of empty runs for all living labs:

Table 48: Summary of decrease in % of empty runs across 12 living labs (target vs actual)

Categories	LLs	Decrease in % of Empty Runs	
		Target Value	Actual Value
Group 1: Intelligent Hubs	LL1	n/a	n/a
	LL2		n/a
	LL3		5%
	LL4		n/a
Group 2: Multi Synchro-modal Transport	LL5	5-10%	5%
	LL6		No access to data
	LL7		n/a
	LL8		not measured
Group 3: Network Optimization	LL9	25-40%	n/a
	LL10		Not measured
	LL11		Not measured
	LL12		n/a

For group 1, intelligent hubs, no target has been set regarding decrease in percentage of empty runs. However, LL3 has used AEOLIX to decrease the empty runs by 5%.

For group 2, multi-synchro modal transport, the value for decrease in empty runs has been set to 5-10%. However, only LL5 was able to decrease the empty runs with the help of AEOLIX by 5% and achieving the lower limit of the target value. LL7 has rail services which are always full, therefore decrease in percentage of empty runs is not valid for them. LL6 has not access to data on decrease of empty runs.

For group 3, network optimization, the target is set to a higher value range of 25-40%. However, none of the living lab from this group measured the decrease in percentage of empty runs. LL9 has implemented AEOLIX in rail services which are always full, therefore decrease in empty run is not applicable. LL11 is currently using TMS and is expecting to integrate AEOLIX with it in future. Then, it will be possible for LL11 to measure the decrease in percentage of empty runs. Finally, LL12 was mainly focused on the use of e-CMR for saving hours in waiting time and administrative processes resulting in not applicability of this KPI.

Reduction of Waiting Time for Trucks in the Terminal

Following Table 49 summarizes target versus achieved or estimated (actual) values related to reduction of waiting time for trucks in the terminal.

Table 49: Summary of reduction in waitingtime across 12 living labs (target vs actual)

Categories	LLs	Reduction of Waiting Time	
		Target Value	Actual Value
Group 1: Intelligent Hubs	LL1	35-40%	22.22%
	LL2		No access to data
	LL3		No considerable difference
	LL4		3.88%
Group 2: Multi Synchro-modal Transport	LL5	n/a	n/a
	LL6		50%
	LL7		n/a
	LL8		50%
Group 3: Network Optimization	LL9	n/a	n/a
	LL10		n/a
	LL11		50%
	LL12		74.61%

For group 1, intelligent hubs, the target value of 35-40% was set regarding reduction of waiting time for trucks in the terminal. Only LL1 and LL4 were able to measure this with values 22.22% and 3.88%. These values are quite low as compared to the set target especially for LL4 (for further details see the relevant section under LL4 operational impact assessment). LL3 has no access to the data and for LL2 there is not much difference in waiting time for trucks in the terminal before and after AEOLIX implementation.

For groups 2 and 3 (multi-synchro modal transport and network optimization), no targets values were set regarding reduction of waiting time for trucks in the terminal. However, LL6 and LL8 (group 2) were able to achieve the reduction of waiting time by 50% each. This is quite a high value, even compared to the target value of 35-40% for . Similarly, LL11 and LL12 reported reductions of waiting times by higher values of 50% and 74.61%, respectively. For reduction of waiting time, LL12 have gained the most benefit especially with the use of e-CMR.

Increase of Terminal Productivity

Following Table 50 summarizes target vs achieved or estimated (actual) values related to increase of terminal productivity for all living labs:

Table 50: Summary of increase in terminal productivity across 12 living labs (target vs actual)

Categories	LLs	Increase of Terminal Productivity	
		Target Value	Actual Value
Group 1: Intelligent Hubs	LL1	15-40%	No access to data
	LL2		No considerable difference
	LL3		n/a
	LL4		4.10
Group 2: Multi Synchro-modal Transport	LL5	n/a	n/a
	LL6		33.33%
	LL7		n/a
	LL8		50%
Group 3: Network Optimization	LL9	n/a	n/a
	LL10		n/a
	LL11		n/a
	LL12		n/a

For group 1, intelligent hubs, the target value with a wide range of 15-40% has been set regarding increase in terminal productivity. Except LL4 with maximum of 4.10% increase in terminal productivity, none of the other living labs from this group, measured this KPI. LL4 has some other factors as a part of terminal productivity, but none of the other factors have higher value than this. For LL2, there is not much of a difference in terms of increase of terminal productivity. LL1 does not have access to data from their partners and LL3 was not involved in this type of activity after the amendment.

For groups 2 and 3, multi-synchro modal transport and network optimization, no targets have been set regarding increase of terminal productivity. However, LL6 and LL8 (group 2) were able to achieve the increase of terminal productivity by 33.33% and 50%, respectively. For this KPI, LL8 has benefited the most from the use of AEOLIX at their facilities.

Increase of % of Load Factor

Following Table 51 summarizes target versus achieved or estimated values (actual) related to increase in percentage of load factor for all living labs.

Table 51: Summary of increase in load factor across 12 living labs (target vs actual)

Categories	LLs	Increase in % of Load Factor	
		Target Value	Actual Value
Group 1: Intelligent Hubs	LL1	30-35%	No access to data
	LL2		no considerable difference
	LL3		3%
	LL4		No access to data
Group 2: Multi Synchro-modal Transport	LL5	n/a	n/a
	LL6		n/a
	LL7		n/a
	LL8		n/a
Group 3: Network Optimization	LL9	35-40%	n/a
	LL10		103%
	LL11		3%
	LL12		n/a

For group 1, intelligent hubs, the target value with a higher value of 30-35% was set regarding increase in percentage of load factor. However, only LL3 was able to use AEOLIX to measure the increase in

load factor percentage with a value of only 3%. This quite low than the target value. LL1 and LL4 do not have access to data from their partners.

For groups 2, multi-synchro modal transport, no targets was set regarding increase in percentage of load factor, and none of the living lab measured it.

For group 3, network optimization, the target of 35-40% was set regarding increase in load factor. Only LL10 was able to achieve way more than the target with 103% increase in load factor. LL11, on the other hand, was only able to achieve a small amount of 3% increase in load factor. LL9 has implemented AEOLIX in rail services which are always full, therefore increase in load factor is not applicable. Finally, LL12 was mainly focused on the use of e-CMR for saving hours in waiting time and administrative processes, and therefore increase in load factor is not applicable for the living lab.

Administration Work

In addition to the above mentioned set targets, AEOLIX has been helpful in administrative work. The major benefits of AEOLIX were associated with reducing the time spent on papers and other administrative processes. LL3 and LL5 were able to save 40% of their time spent on administrative works. However, LL4 could only save 14% of the time on administrative work. LL6 and LL8 has been the most successful ones by saving 75% and 83,80% of their times on administrative works. LL6 saved most of the time related to administrative processes at the port of Bordeaux. On the other hand, LL12 had the special focus of reducing the administrative process time with the use of e-CMR. Based on the results, this can be said that LL12 has been extremely successful in achieving its targets.

Custom Procedures

Last but not the least, LL4 was able to save 4,70% of its time spent on custom procedures. The use of AEOLIX in custom procedures has been the part of evaluation discussion where it is seen as a potential candidate for saving times even beyond European boundaries.

6.2.2. Business impacts (money)

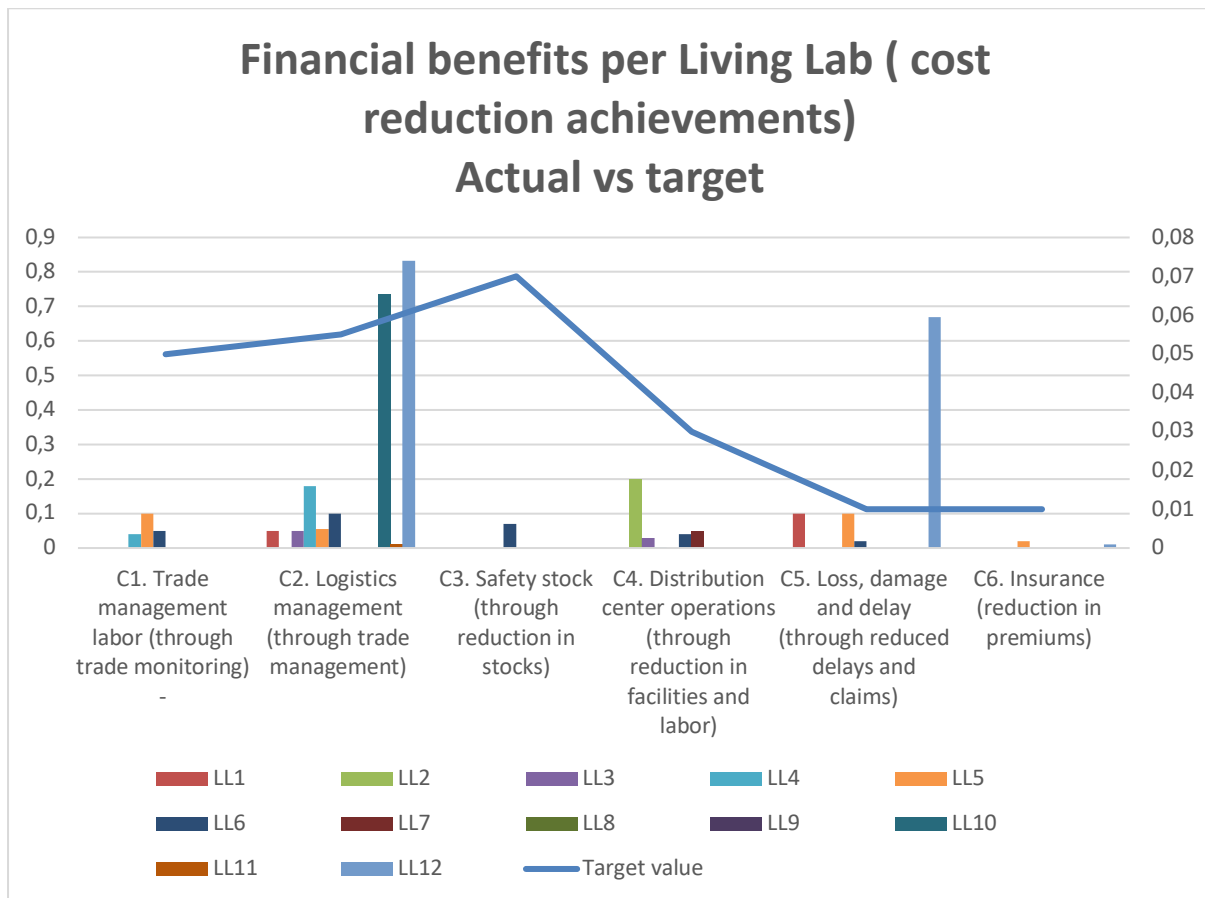


Figure 193: Financial benefit or cost savings across 12 LLs (target vs actual)

One of the main goals with AEOLIX was to reduce the costs for various logistics activities within living labs. The previous section has outlined number of benefits in terms of reducing the consumption of various resources, reducing times for various activities and increasing the productivity in certain areas. A summary of various costs advantages is shown in the Figure 193 above.

Trade Management Labor

Trade management labor is mainly concerned with trade monitoring. The analysis of results show that only three living labs were able to save or estimate savings for this type of cost. These living labs are LL4, LL5 and LL6. While the target value was considered to be above 5%, LL5 estimated highest benefit with 10% reduction in costs related to trade management labor. LL6 was the second highest with 5% in reducing costs related to trade management. Finally, LL4 could only save up to 4% for the costs related to trade management labor through trade monitoring activities.

Logistics Management

The reduction in logistics management costs is achieved by saving money on trade management activities. More than 50% (7 out of 12) of the living labs were able to save money on this type of cost



while some claiming much higher benefits than the expected target of 5.5-6%. These living labs included LL 1, LL3, LL4, LL5, LL6, LL10, LL11 and LL12. LL1 and LL3 estimated or achieved 5% which was a little below the target value of 5.5-6%. However, LL5 estimated that it will be able to achieve the cost saving target of 5.5% in future. LL1 was the only living lab which estimated or achieved the lowest value of 1% for this type of cost. LL6 and LL4 had higher benefits with 10% and almost 18% on cost savings, respectively. There are exceptions, however, for LL10 and LL12 who claimed to achieve the estimation of over 73% and 83%, respectively.

Safety Stock

Nowadays, it is very critical for companies to maintain the stock level for business growth and trustworthy customer relationships. On one hand, companies are trying to keep the stock level to the minimum required amount. On the other hand, they have to pay a huge amount of money for renting warehouses, paying personal salaries and so on. AEOLIX was successful for LL6 by reducing its inventory related costs by 7%, achieving the target set for this type of cost. AEOLIX has been successful for LL6 in reducing the cost related to stock by 7%, hence achieving the target set for this type of cost.

Distribution Center Operations

A major part of distribution center operations costs is related to the costs of facilities and labor. A target range of reduction in cost by 3-5% has been set for distribution center operations. Only five living labs have reported that they have achieved or will be able to save the costs related to distributed center operations. These living labs include LL2, LL3, LL4, LL6 and LL7. Only LL4 has reported a value of less than 1% in cost reduction which quite below the target value. While LL3, LL6 and LL7 were able to achieve the target value by saving 3%, 4% and 5% on the money, respectively.

Loss, Damage and Delay

Many companies are experiencing non-productive costs including the loss of products during the delivery, damage to delivered products or vehicles involved in delivery and claims made on delay of products delivery. The seamless information sharing and communication via AEOLIX has helped a number of living labs to save money related to this type of cost. LL1, LL5, LL6 and LL12 were able to save the money for loss, damage and delay related costs. The target for this type of cost was set to 1-3% for all living labs. All living labs outperformed in saving this type of cost savings except LL6 who still met the target with 2% savings on delays. LL1 and LL5 achieved or estimated the benefit level of 10% each by through reduced delays and claims costs. Finally, LL12 was the one with the most financial benefit of 67% reduction in costs using e-CMR. The living lab had mainly saved costs related delays in the processing of administrative activities.

Insurance

Last but not the least, couple of living labs were able to save costs on insurance through reduction in premiums. The target for reduction in insurance cost is set to 1% for all living labs. LL12 estimated to achieve the target with 1% reduction in costs related to premium. Finally, LL5 estimated to save money with by 2% reduction in costs.

A summary of target values for these costs versus achieved or estimated is presented in Figure 194 below:

		LL1	LL2	LL3	LL4	LL5	LL6	LL7	LL10	LL11	LL12
Costs Types	Target value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value	Achived/ Estimate d Value
C1. Trade man/agement labor (through trade monitoring) -	5%	n/a	n/a	n/a	3,94%	10,00%	5%	n/a	n/a	n/a	n/a
C2. Logistics man/agement (through trade man/agement)	5,50%	5%	n/a	5%	17,89%	5,50%	10%	n/a	73,36%	1%	83,33%
C3. Safety stock (through reduction in stocks)	7%	n/a	n/a	n/a	n/a	n/a	7%	n/a	n/a	n/a	n/a
C4. Distribution center operations (through reduction in facilities and labor)	3%	n/a	20%	3%	0,06%	n/a	4%	5%	n/a	n/a	n/a
C5. Loss, damage and delay (through reduced delays and claims)	1%	10%	n/a	n/a	n/a	10%	2%	n/a	n/a	n/a	67,00%
C6. Insurance (reduction in premiums)	1%	n/a	n/a	n/a	n/a	2%	n/a	n/a	n/a	n/a	1%

Figure 194: Cost Savings in percentage for all 12 LLs (target vs acutal)

6.3. Environmental Impacts Summary

6.3.1. CO2 Emission

An overall value of 20% has been set for reduction in CO₂ emission with the use of AEOLIX for its partners in different living labs. LL1 and LL3 were able to reduce the carbon footprints by 12.21% and 17%. On the other hand, LL5 and LL6 have achieved or estimated 20% reduction in carbon footprints. LL10 has been the most successful in reducing carbon foot with 43.10% using AEOLIX. No other living lab has reported the reduction in carbon footprints. A summary of results has been shown in Figure 192 in the previous section.

6.3.2. Reduced Noise Pollution

This section will provide information on how AEOLIX has helped in reducing noise pollution at various living labs. The analysis of the results show that AEOLIX and its various functions have quite a considerable impact on reducing noise pollution. Following Figure 195 shows the contribution of AEOLIX and various components on reducing noise pollution.

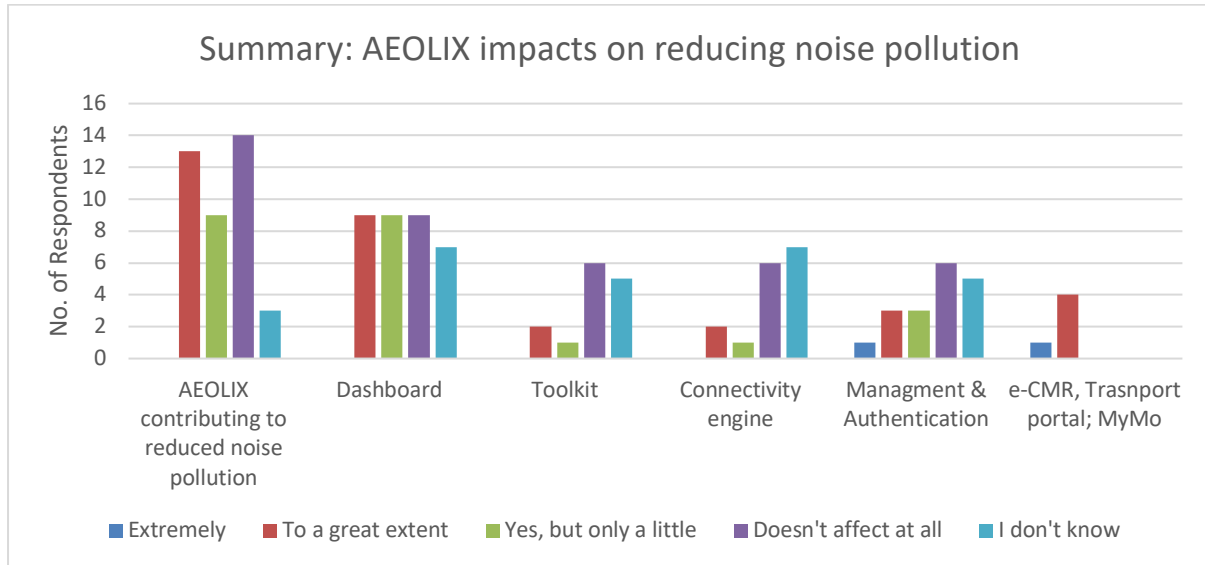


Figure 195: AEOLIX impact on reduced noise pollution across 12 LLs

The analysis shows that AEOLIX in general has varied impacts on reducing noise pollution at different living labs. At all 12 living labs, 13 of the respondents think that AEOLIX has helped 'to a great extent' in reducing the noise pollution. On the opposite side, similar number of people have the view that use of AEOLIX 'does not affect at all' in reducing noise pollution. A closer number of respondents (9) persons think that AEOLIX helps 'but only a little' in reducing noise pollution. Finally, only fewer number of people (3) do not have any opinion on the affect AEOLIX on reducing noise pollution.

In terms of Dashboard usefulness, the respondents' results ranges from helping to reduce noise pollution from 'to a great extent' to 'but only a little' and even 'doesn't affect at all'. A point of observation is that people with all these three view are equal in number (9 respondents). However, a considerable number of people (7) are unaware of Dashboard impacts on reducing noise pollution.

Toolkit and connectivity engine functions have not received very high number of positive responses. Few respondents believe that both functions individually will contribute 'to a great extent' or 'to a little extent' reducing noise exposure. A bigger number of respondents (5 or 6) stated that both functions individually do not impact on reducing noise pollution. Finally, the rest (5 or 6) are unaware of toolkit function role in reducing noise pollution. This unawareness is due to the fact that not all respondents are not using these functions.

Like toolkit and connectivity engine, management and authentication function received very little positive response on being useful for reducing noise pollution 'to a great' or 'a little' extents. Many respondents see not an effective use of the authentication and management function in reducing noise pollution. This little use is based on respondents common view about the function which either 'doesn't affect at all' or they are unaware of the role of the function. Interestingly, couple of respondents still think that the function is 'extremely' helpful in reducing the noise pollution.

In addition to set AEOLIX functions, e-CMR, MyMo and Transport portal has been rated as helpful 'to a great extent' in reducing the noise pollution.

6.4. Socio-economic Impacts Summary

Socio-economic aspect includes job creation, SMEs empowerment and improved quality of life for employees.

6.4.1. Job Creation

This section will provide information on how AEOLIX has helped in creating new jobs at various living labs. Following Figure 196 shows if AEOLIX has helped in creating operational level jobs of drivers and terminal, hub or port operators. The result shows that many people are unaware of the actual or even anticipated impact of AEOLIX on both types of job creation. This is because the AEOLIX implementation is a new phenomenon and it is difficult to predict or expect the exact impact. However, few respondents think that AEOLIX may require '1-2 operators jobs per year'. This is even interesting in case of drivers jobs where a respondent has anticipated 3-4 jobs per year. This may be due to increase in business or the need of new skills.

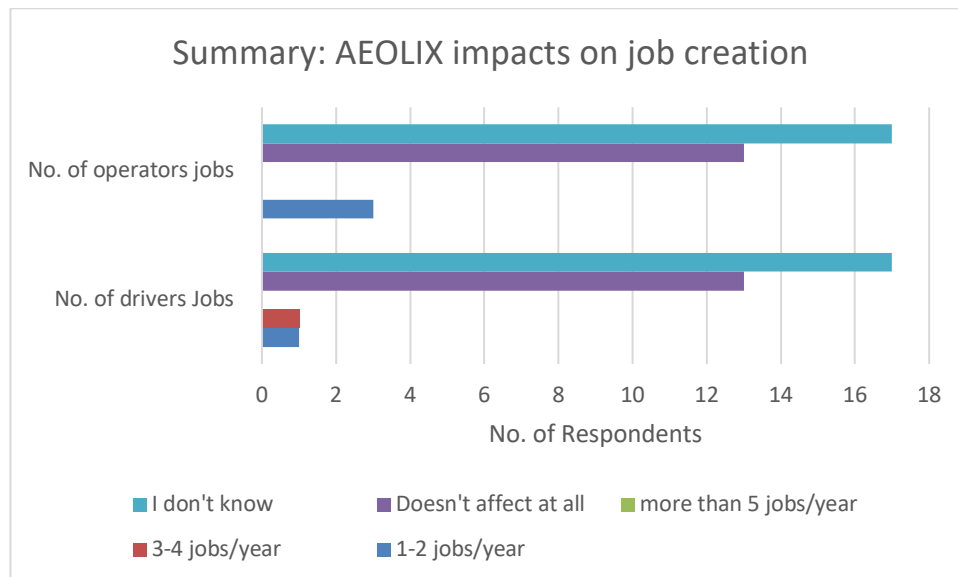


Figure 196: AEOLIX impact on job creation across 12 LLs

6.4.2. SMEs Empowerment

SMEs empowerment has two aspects: increased collaboration with large organizations and increase in market share. Both the aspects have shown varied results ranging mostly from 'to a great extent' to 'I don't know'. Following Figure 197 shows the variation in responses for both aspects.

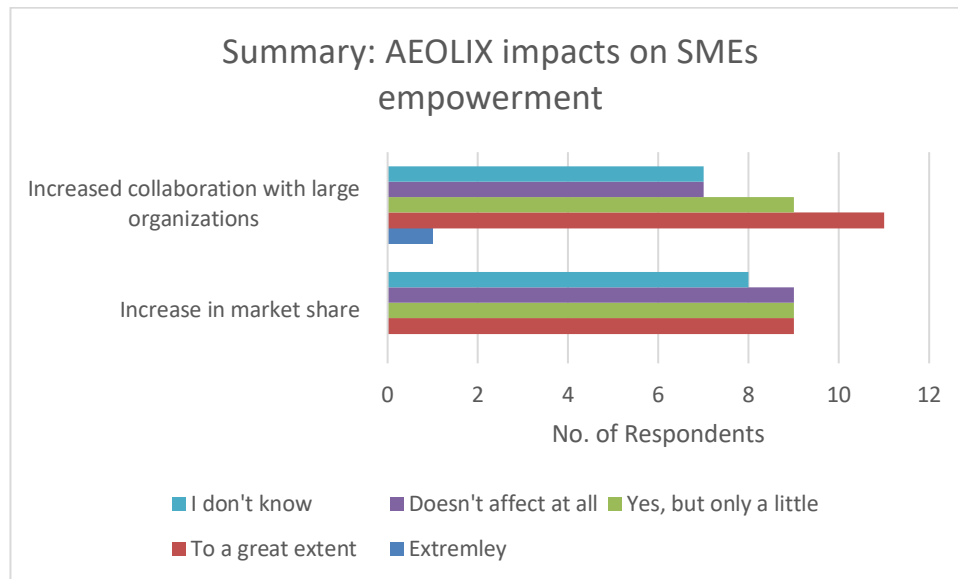


Figure 197: AEOLIX impact on SMEs empowerment across 12 LLs

For increase collaboration with large organizations, most of the respondents (11) think that AEOLIX will help SMEs to have better relationships with big players in logistics. A closer number of respondents (9) are of the view that AEOLIX will help 'but only to a little' extent in building relationships and collaborations with large organizations. A considerate number of respondents (7 for each view) think that AEOLIX either 'doesn't affect' increase collaboration with large organizations or they are 'unaware' if it will help at all.

Increase in market share also has a varied but more symmetrical number of responses. These responses include 'to a great extent', 'yes, but only a little' and 'doesn't affect at all'. Equal number of respondents (9) are carrying the one of the views mentioned above. However, equally considerable number of people are unaware if AEOLIX has or will help in increase market share for SMEs.

6.4.3. Improved Quality of Life

This section will provide information on how AEOLIX has helped in improving quality of life at various living labs. This study has considered a number of aspects related to improved quality of life including the followings:

- AEOLIX helping employees to put more focus on work
- AEOLIX helping in reducing stress level of employees at work
- Other employees have shown positive change in attitude for those using AEOLIX
- Employees have been rewarded for using AEOLIX e.g. in terms of less working hours, flexibility in working hours

Following Figure 198 shows the summary of results for each of the aspect related to improved quality of life.

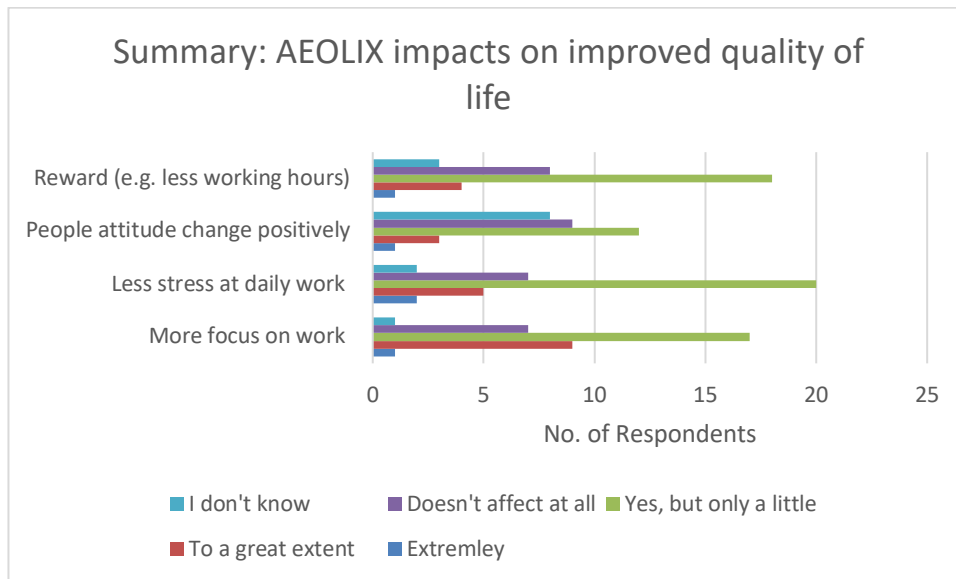


Figure 198: AEOLIX impact on improved quality of life across 12 LLs

For AEOLIX helping to put more focus on work, most of the respondents (17) shared the view that AEOLIX was useful ‘but only a little’. Another considerable number of respondents (9) replied that it was useful ‘to a great extent’. Another equally considerable number of respondents (9) shared the view that AEOLIX ‘doesn’t’ help to put more focus on work. Finally, only one respondent see that AEOLIX will be ‘extremely’ helpful in focusing on work.

Similarly, majority of respondents (20) found AEOLIX to be helpful ‘but only a little’ in reducing stress level of employees at work. Second largest group of respondents (7) did not found AEOLIX useful in reducing stress level by responding that it ‘doesn’t affect at all’. However, still a considerate number of respondents (5) found AEOLIX helpful ‘to a great extent’ in reducing stress level at work. Finally, a very small number of respondents (2) were ‘extremely’ optimistic about AEOLIX role in reducing the stress level. The remaining respondents (2) were unaware of AEOLIX role in reducing the stress level at work.

When it comes to positive change in people attitude for those using AEOLIX, many respondents (12) thought that it will help ‘but only a little’. Many other think that it ‘doesn’t affect at all’ (9) or are unaware (8) of AEOLIX role in building positive image of employees. Very few still think that AEOLIX is of a great value (3) or even extremely (2) helpful to contribute to the positive image at work.

In addition to aforementioned benefits, AEOLIX brought rewards for those using it ‘but only to a little extent’ (17). On the other hand, a considerable number (8) doesn’t see AEOLIX bring reward to the employees, directly. However, a small but still countable number of respondents (4) have seen or anticipated ‘great’ value of AEOLIX in rewarding employees at work.

6.5. AEOLIX acceptance and Trust at LLs

In addition to above mentioned aspects, acceptance and trust on AEOLIX is a significant component to assess the successful implementation and adoption of the system. The following Figure 199 shows

how AEOLIX acceptance and trust impact on degree of AEOLIX approval by its users, relationship with user, improved service quality, increased responsiveness, improved efficiency of operations, and improvement in planning and overall performance outperformed. Most of the responses from 12 LLs evaluation managers showed that AEOLIX use was directly related to the degree of approval 'to a great extent'. However, there were still some who thought that it affected 'to a little extent' only. However, change in AEOLIX acceptance and trust level reflected equally diverse opinions. Most of the respondents (5) thought that AEOLIX acceptance impacted on relationship with user while an equal number of respondents shared the view that it impacts 'to a little extent' only. Similar results were found with AEOLIX acceptance impacting overall planning and performance with the equal split view. Likewise, the impact of AEOLIX acceptance and trust on increase responsiveness and improved service quality showed exactly the same split views. Four respondents in each case thought that AEOLIX acceptance impacts increased responsiveness and improved service quality 'to a great extent'. On the other hand, another four respondents agreed that AEOLIX acceptance impacts both, 'but only a little'. One exception was that one respondent observed that AEOLIX 'doesn't affect at all' on increased responsiveness. Lastly, a big proportion of respondents (5 out of 11) shared the view that AEOLIX acceptance was directly related to improvement in efficiency of operations 'to a great extent'. Another considerable number (3) of respondents believed that the AEOLIX acceptance impacted the improvements in efficiency of operations, 'but only a little' extent.

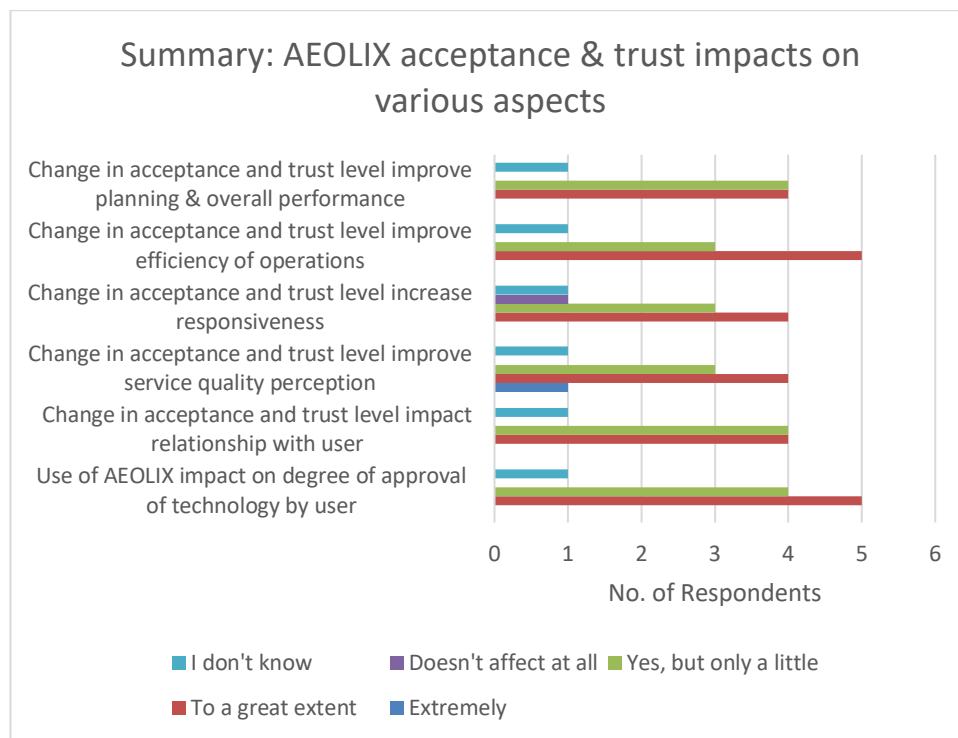


Figure 199: AEOLIX acceptance & trust impacts on various aspects across 12 LLs

The study further asked: ***To what extent, various AEOLIX functions were perceived useful and actually proven to be useful?***

Following Figure 200 shows the usefulness of Dashboard, Connectivity engine and toolkit services as perceived by 12 LLs evaluation manager.

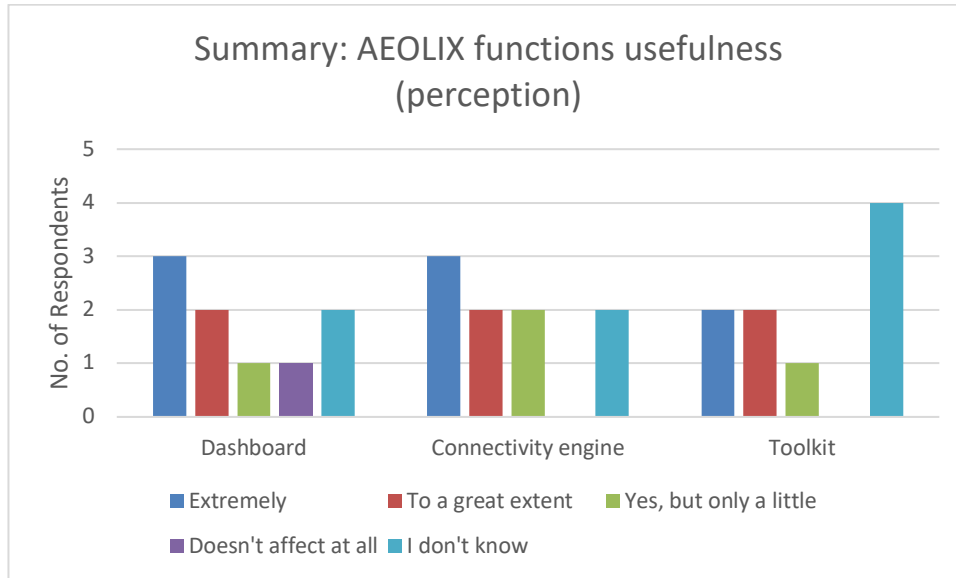


Figure 200: AEOLIX functions usefulness across 12 LLs (perception)

Dashboard

Three respondents had the perception that AEOLIX will be 'extremely' useful. However, only one respondent found it 'extremely' useful after using AEOLIX. A fewer number (2) of managers thought that AEOLIX would be useful 'to a great extent'. However, double the number of managers (4) found it actually useful 'to a great extent' after using Dashboard. Furthermore, there were very few respondents (2) who initially thought that AEOLIX Dashboard function would be useful 'only a little' or have no affect at all. However, after using AEOLIX equal number of participants (3 each) found that AEOLIX was useful 'to a little extent only' or have no useful impact on their business operations. In summary, AEOLIX Dashboard usefulness had been perceived as 'extremely' and 'to a great extent'. However, AEOLIX was mainly proven to be useful 'to a great extent' with a variation of very little usefulness or even not useful in some cases.

Connectivity engine

Like Dashboard, the perceived and actual usefulness of connectivity engine also showed split views. In the beginning of AEOLIX, a considerable number of LLs evaluation managers (3) thought that connectivity engine would be 'extremely' useful. However, only two managers found it 'extremely' useful during the project. Furthermore, two of LLs evaluation managers perceived the engine to be useful 'to a great extent' while other two thought that it would be useful 'but only a little' and another two did not had opinion. At the end of AEOLIX, an increasing number of LLs evaluation managers (6) were satisfied with the connectivity engine usefulness 'to a great extent'. There was only one manager who found it useful 'to a little extent' and another one has not used it. Therefore, a conclusion can be drawn that connectivity engine is proven to be useful 'to a great extent' at the end of AEOLIX project.

Toolkit Services

The toolkit service function of AEOLIX had either with very high expectations by LLs evaluations managers or no expectations in the beginning of the project. In total, four out of 12 participants

thought that toolkit services would be ‘extremely’ or, at least, ‘to a great extent’ useful. Only one manager thought that it will be helpful only to a little extent. In addition, another four LLs evaluation managers had no idea of the usefulness of toolkit services in their Living Labs (Figure 201 below). However, after using AEOLIX none of the LL evaluation manager found toolkit ‘extremely’ useful. Four LLs evaluation managers have found it useful ‘to a great extent’ and only one found ‘a little’ usefulness of the toolkit services. Quite surprisingly, three participants shared an opinion that toolkit services were not useful at all. One last manager is unaware of its usefulness. The low usefulness of toolkit is because of the reason that many LLs evaluation managers either did not use the toolkit functionalities or have used it for a very little time.

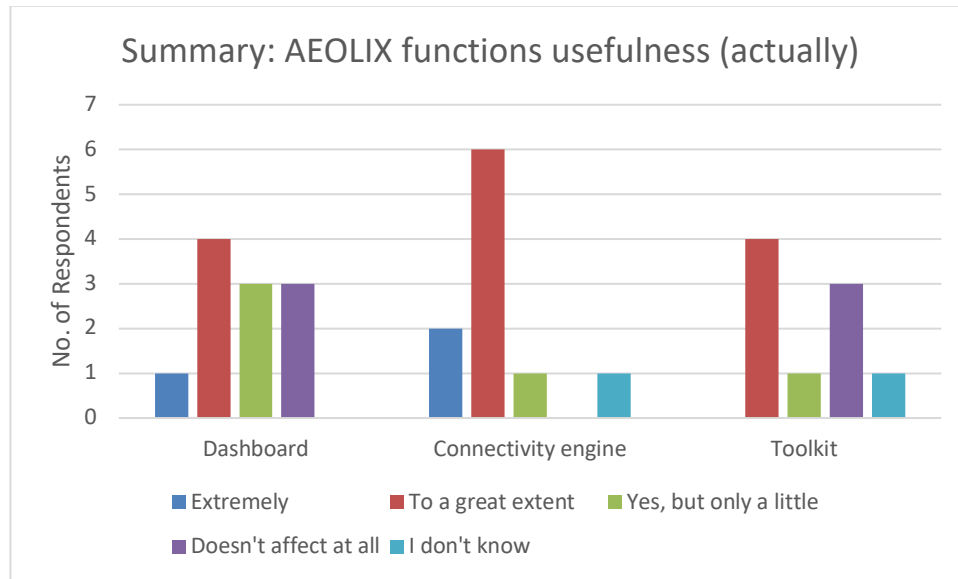


Figure 201: AEOLIX functions usefulness across 12 LLs (in actual)

This study further probed into the what was actually expected of AEOLIX and what users got. For living labs, AEOLIX was perceived as a system for providing faster paperless procedures and better reallocation of workloads. Managers at companies are satisfied with the AEOLIX in meeting their expectations.

This study continued to ask about users willingness to continue using AEOLIX: ***To what extent, users are willing to continue using various AEOLIX functions?***

Users willingness to continue using AEOLIX and its various functions is directly related to the usefulness, they experienced. The study shows that various AEOLIX functions were proven to be useful ‘to a great extent’. This means the more useful a function is, the more willing users are to continue using it. Again, the results showed split views on users willingness to continue using various AEOLIX functions.

Two of LLs evaluation managers seemed to be ‘extremely’ eager to continue using Dashboard. This is because of the reason that they found it extremely useful or see huge potential for their businesses in the future. Another four managers showed their willing to continue using Dashboard ‘to a great extent’. Thus 6 out of 11 respondents expressed very positive intentions. Two more managers stated limited but still positive intent to continue using it. Three more managers out of the 11 were not using

the functionality at all. Therefore, they showed either very little eager to use dashboard or they are completely uninterested in using the functionality.

Connectivity engine, on the other hand, revealed a bit more positive result. A manager was extremely interested in having connection with other stakeholders through the connectivity engine. Another five LLs evaluation manager expressed their willingness 'to a great extent' to continue using the connectivity engine functionality. However, another two managers are not sure if they will continue using connectivity engine or not within their living labs.

Finally, toolkit services showed an average results by respondents when they were asked about their willingness to continue using the function. Only one manager is extremely interested in continue using the toolkit services functionality. A number of managers (4) are willing 'to a great extent to continue using toolkit services. However, another five out of twelve either do not see any benefit or unaware of the benefits that toolkit services can bring to their businesses. The summary of respondents results on willingness to continue using AEOLIX functions is presented in Figure 202 below:

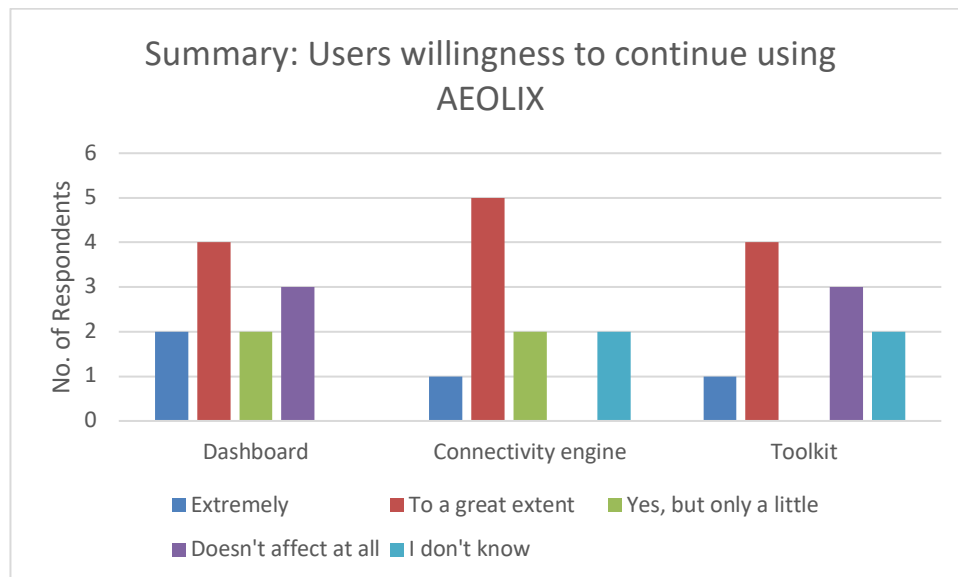


Figure 202: Users willingness to continue using AEOLIX across 12 LLs

After willingness to continue using AEOLIX, we asked about trust on various components:
To what extent, users trust on various AEOLIX functions?

In total, Three respondents characterized their trust in Dashboard as *Extremely* positive, or to a *Great Extent*. Three more Managers state their trust positively but 'only to a little extent', probably due to their limited use of it. Five out of 11 responses have no opinion or don't know because either they were unsure or did not use it at all.

Connectivity engine on the other hand did not win an absolute trust of any LL evaluation manager. Only three managers trusted on connectivity engine 'to a great extent' as long as it kept them connected to other stakeholders. Another three showed 'very little' trust on connectivity engine mainly due to frequent interruptions experienced during the use of AEOLIX. Another three were not sure about the usefulness and therefore do not share any opinion about trust AEOLIX connectivity engine.

Like connectivity engine, toolkit was unable to win an absolute trust of any living lab evaluation manager. However, one-fourth of living labs evaluation managers trusted toolkit 'to a great extent'. Only one trusted it 'to a little extent' and another two did not trust the services provided by toolkit. Finally, one-third of LLs evaluation manager are not sure if they should trust toolkit service or not as they did not use the services. A summary is presented in Figure 203 below.

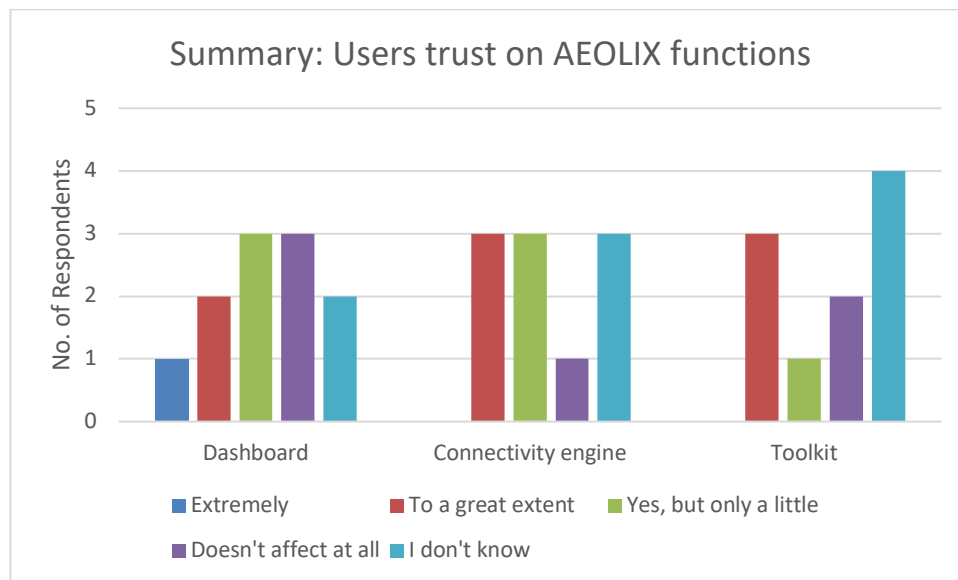


Figure 203: Users trust on AEOLIX functions across 12 LLs

Another important aspect related to acceptance of AEOLIX is how easy is it to learn the new functions of the system. Therefore, this study asked ***To what extent, users perceived that learning AEOLIX was easy and how it actually proven to be?***

Easy of learning AEOLIX also is recognized as having direct relationship with the acceptance of the system. That is, if a system is actually proven to be easy and quick to learn, users are more willing in accepting and adopting the system. Before the project, AEOLIX had perception among most of the company managers that it will be 'extremely' (8 manager) or, at least, 'to a great extent' (13) easy to learning features of AEOLIX. A considerable number of managers (8) also expected that it will not be too easy to learn the functions of AEOLIX. However, there was a decrease in number of people who thought that it will be extremely easy (down to 4 from 8) or who thought that it would be easy 'to a great extent' to learn (down to 10 from 13). On the other hand, there was an increase in number of people who found that AEOLIX learning experience was not so easy (up from 8 to 13). Finally, more people believed that ease of learning of AEOLIX had not been easy at all. Following Figure 204 shows the summary of respondents on ease of learning perception vs actual experience of learning AEOLIX.

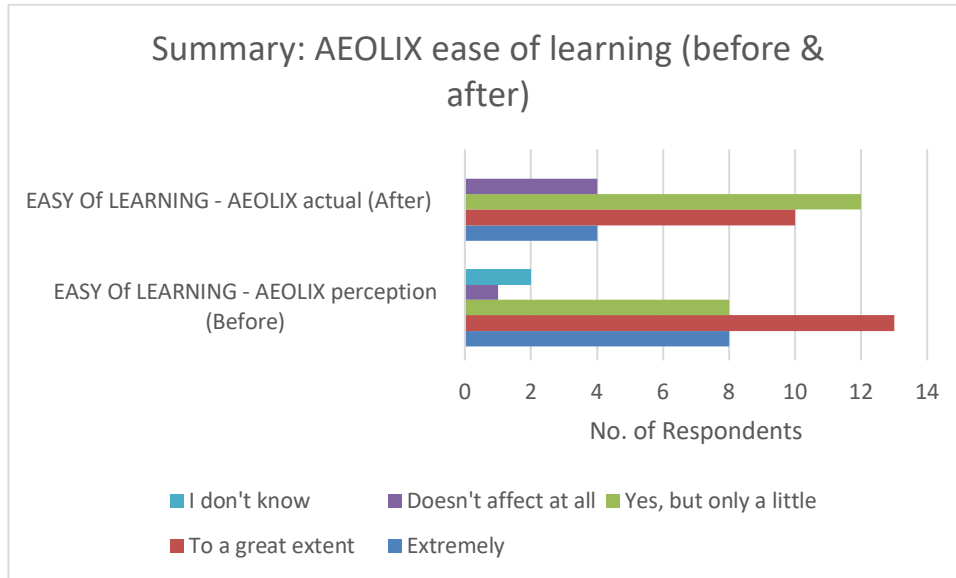


Figure 204: AEOLIX ease of learning across 12 LLs (perception vs actual)

This study has further investigated number of aspects related to AEOLIX acceptance. The results are presented in the Figure 205 below:

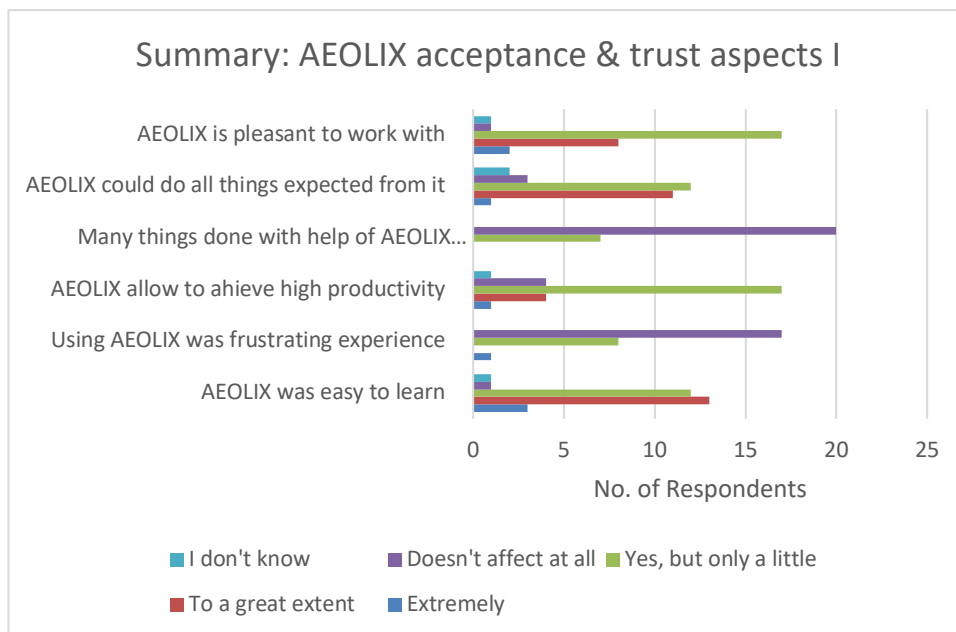


Figure 205: AEOLIX acceptance & trust aspects-I across 12 LLs

The results depict that only couple of managers found it frustrating to use AEOLIX. Most of the respondents experienced no frustration at all (17) or just 'little' moments of frustration (8). Furthermore, most of the managers (17) shared the common view that AEOLIX allowed them to achieve high productivity. Only few had experience high productivity 'to a great extent' or see the future potential of AEOLIX contributing to high productivity. However, AEOLIX has met it expectations 'to a great extent' (12) but many others (13) observed 'very little' cases where it has met its expectations. This low performance versus expectations can, from our point of view, lead to low

acceptance of AEOLIX. Though AEOLIX did not meet high expectations to a great extent, it was useful and did not led company business in wrong directions. Finally, a considerable number of companies managers (10) found it quite pleasant to work with AEOLIX. However, a big number of managers (17) experienced moments when it was pleasant to work with AEOLIX but not all the time.

Eventually, this study probed into further aspects related to AEOLIX acceptance and trust as shown in Figure 206 below:

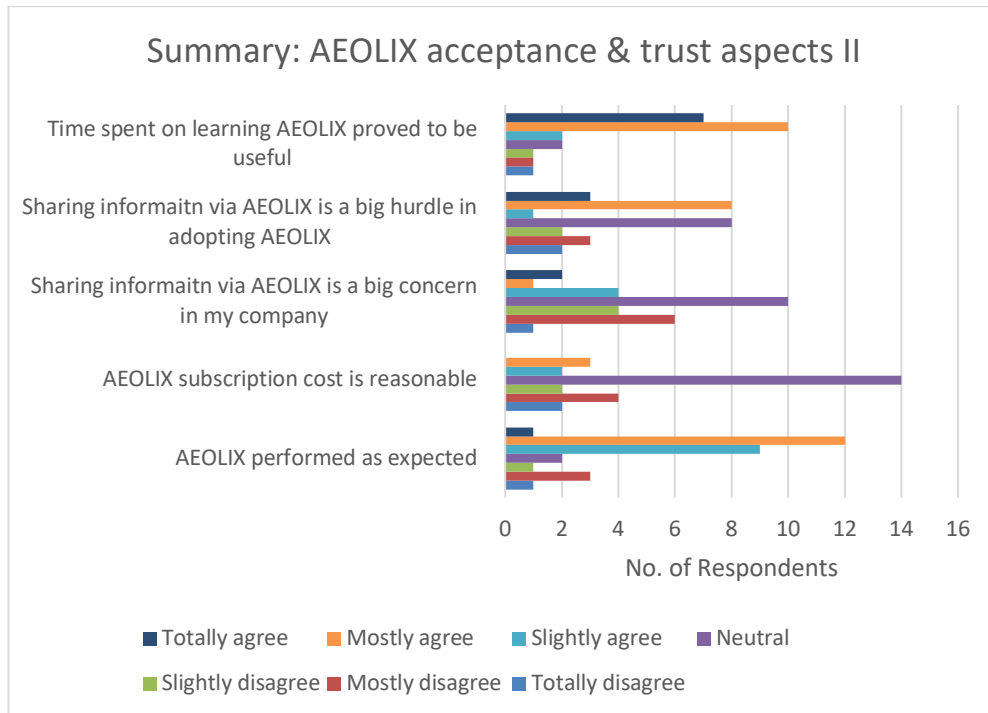


Figure 206: AEOLIX acceptance & trust aspects-II across 12 LLs

The results of further responses suggested that AEOLIX mostly (12) met the performance expectations. A considerate number of companies' manager (9) slightly agreed with the claim that AEOLIX met its performances expectations. On the contrary, some made the opposite experience (3) and even not satisfied with performance expectancy. Yet still one of respondent was 'extremely' satisfied with the performance of AEOLIX.

Sharing information via AEOLIX had been one of the focal points of discussion during the project within living labs. Many company managers observed that sharing information via AEOLIX was not a big hurdle in accepting and adopting the system 'to a great extent'. While many others showed neutral opinions on the view that sharing information is a big hurdle. However, there were few managers who found it easy to share information via AEOLIX and adopting the system, independent of information sharing concerns.

Usually, companies value their times which they spent in learning and implementing new systems. The time spent on learning and implanting AEOLIX in companies was regarded as having a great value. Finally, a big number of respondents were not sure how the AEOLIX subscription cost will work out in the future. Therefore, they have a neutral view on the viability of subscription cost for using AEOLIX.



Last but not the least, there are few who have opposite view on the cost. In other words, some business managers think that the cost is not reasonable at all and others think that the cost of the AEOLIX living laboratory subscription is fully reasonable. For further details on costs and benefits, see deliverable 6.3 and 8.5 of the AEOLIX project.

7. Conclusions and Recommendations

In order to capture the impacts assessment at operational level, this report used a mixed method approach consisting of quantitative as well as qualitative methods. The quantitative data collection includes conducting surveys and analyzing by calculating simple totals, averages, and percentages, and statistical tests. On the other hand, qualitative data was collected using interview guides and interpreting findings in relation to questions. During the analysis, this report watched out for unintended results and data that does not fit to expectations. So far, the data has been collected from various actors within all living labs. These actors include living labs evaluation managers, company representatives or managers, operators and drivers.

This report has presented various aspects related to the operational impact assessment where AEOLIX has made impacts to a varying extent. Some of the financial benefits are as follows:

- Some of the aspects can be measured quantitatively, that is, a numerical value is available. For the AEOLIX living labs operational impacts assessment, reduced operational costs (business) and carbon footprints (environmental) could be measure quantitatively. This means a numerical value is possible to calculate for CO2 emission and operational costs.
- Some aspects could only be measured qualitatively. These aspects include SMEs empowerment, job creation and quality of life (socio-economic) and noise pollution (environment). For these aspects, qualitative surveys (for companies in living labs, operators and drivers) and qualitative KPIs were (e.g. level of service, Acceptance and trust) were used to assess the impacts on the operational levels. This report has presented an assessment on AEOLIX operational impact assessment related to business, environmental and socio-economic aspects. Based on the analysis of results, a number of concluding remarks along with recommendations are presented in this section.
- AEOLIX helped living labs to save resources and time spent to carry out various logistics activities. The economic or business benefits came along two dimensions: (i) in terms of time; and (ii) in terms of money. In terms of time, AEOLIX facilitated reducing the time spent on various activities at the companies. In terms of money, AEOLIX helped to save costs on various logistics activities within living labs.
 - Results presented in the form of KPIs have outlined number of benefits in terms of reducing the consumption of various resources including reducing times for various activities and increasing the productivity in certain areas.
 - AEOLIX Lack or change of strategic objectives in some LLs led to change of their initial KPIs declared and replaced with others
- Business environments of different Living Labs, even in the same category of living labs, are contextual. This means that each Living Lab focuses on different logistics areas according to local conditions, business visions and goals. This leads to different results for different living laboratories. Variation in results from logistic areas (presented in the form of KPIs) has led to different types of costs benefits and to a varying amount of money.

On top of financial benefits, this report suggests that AEOLIX has positive impact on environmental aspects in terms of reducing carbon footprints and noise pollution. Some important highlight of environmental benefits include the followings:

- The analysis of results reflects that AEOLIX was helpful in reducing carbon footprints for a number of living labs. However, not all of the living labs were able to measure the CO₂ emission. Furthermore, not all living labs were able to achieve the target value of 20% reduction in CO₂ emission. However, the benefits in terms of reduction of CO₂ emission shows that AEOLIX has been helpful in reducing CO₂ emission to a great extent. Summarizing there are only few living labs (LL3, 5 and 6) who were able to achieve up to 20% reduction in CO₂ emission. LL10, on the other hand, outperformed in reducing carbon footprints by 43% with the help of AEOLIX.
- In general, AEOLIX was able to help reducing noise pollution but only to some extent. However, AEOLIX, which facilitates the reduction of noise exposure, was not achieved with great results.. One of the main reasons for this low impact on noise level is that AEOLIX has recently been implemented and it will take time to see the complete impacts. Furthermore, not all living labs are using all four AEOLIX functions, and it is not clear which function is contributing to what extent in reducing noise pollution.

AEOLIX impact on socio-economic aspects were measured in terms of job creation, SMEs empowerment, and improved quality of life.

- This study has explored the impact of AEOLIX on job creation in terms of drivers and operators' jobs. Since the AEOLIX implementation is in its initial phases, respondents are unable to estimate how many jobs (drivers or operators) will be created in the long run.
- SMEs empowerment was measured in terms of an increase in SMEs market share and increase SMEs collaboration with large organizations.
 - For an increase in SMEs market share, most of the respondents foresee that AEOLIX will help to increase the share but only to a little extent.
 - For an increase SMEs collaboration with large organizations, again AEOLIX will be able to help to a little extent only.
- The improved quality of life is measured in terms of AEOLIX helping to put more focus on work, less stress at work, positive attitude towards people using it, and reward for employees in terms of less or flexible working hours.
 - The results reflect that AEOLIX has greatly helped employees to put more focus on work and to reduce stress level.
 - However, there are not clear signs of change in attitude of people for those using AEOLIX for their operational level jobs.
 - Finally, AEOLIX rewarding employees with less or flexible working is mainly seen as a return on investment (ROI) by managers. This ROI is considered as a part of the improving business processes efficiencies by the managers.
- AEOLIX impact on various socio-economic aspect in a positive way but it will take time to visualize or anticipate the benefits brought by the system. One of the main reasons is that changing of social processes are in general quite slow and it takes time to observe any change on social aspects.

In addition to aforementioned aspects, the acceptance and trust on AEOLIX is critical without which it is impossible to gain the benefits. Main findings related to the acceptance and trust on AEOLIX include the followings:

- Users in different living labs found AEOLIX (Dashboard, connectivity engine and toolkit) useful to a varying extent. This extent mainly corresponds to either little or to a great extent meaning that AEOLIX is only a little useful for some and of a great help to others. Users willingness to

continue using AEOLIX functions and their usefulness are directly related to each other. This means the more useful a function is, the more users are willing to continue using it. Again, the results show split views on users willingness to continue using various AEOLIX functions. This should be noted that not all the functions were used by all living labs evaluation managers.

- The advantages of AEOLIX are directly related to the benefits of the AEOLIX functions and the scope of the system's use. . At the moment, AEOLIX has been used very little (i.e. less than 40 hours per month) in most of the living labs. However, it is anticipated that lack of use will be reduced by increase of functionality, training to use the system and transparency in the logistics processes.
- The AEOLIX platform, through various services and functions has a positive impact on society in general and on workers in particular. Although this impact cannot be evaluated financially for the first year of AEOLIX implementation, numerous researches show that a more satisfying and less stressful job, together with a more welcoming and stimulating environment, have an important economic impact in the long-term period. The *Stress in America* survey (Anderson & all, 2015) has estimated that more than 500\$ billion were used due to workplace stress and 550 million workdays are lost each year due to stress at work. Therefore, the fact that AEOLIX has a positive impact on society will also prove to be an economic benefit for the various companies.

Based on results of this study, following recommendations can be very helpful for the continuation of AEOLIX:

- AEOLIX needs to be sure to address all the aspects outlined as success factors, in order to be aligned to market needs and ensure good profitability can be achieved by all supply chain actors in line with their strategy for collaboration.
- Having a platform that connects to other systems such as AEOLIX, means mitigation of risk and greater profitability of organizations can be achieved through proffering connected and collaborative visibility.
- AEOLIX must leverage its position as a neutral certified information exchange, building trust and overcoming the major issues of culture that reside within supply chains. In addition, capacity building for industry on digital connectivity could help.
- Ease of use and integration aligned to understanding the marketplace of existent ICT logistics systems is a must for the AEOLIX. Attention is to be paid to the ability for AEOLIX to engage with leading software without 'middle ware' which leave supply chains open to vulnerabilities [security].
- Clear strategy is important (either agile or responsive or cost focused or innovative) to set the appropriate objective and ultimately the KPIs and to right basis for collaboration and partnership
- As more companies are added to the platform, even greater efficiencies will be delivered due to proliferation of synergies and strategic partnerships. For example decreasing the empty runs resulting in reducing the shipment cost. Collaboration can result in the reduction of the collective empty runs. This can be achieved by brokering freight to each other and, in a way, exchanging customers. In addition to improving margins and asset utilization, the



collaboration can reduce both company's overall km driven, leaving a smaller carbon footprint.

- Sharing information via AEOLIX turned out to be a part of important debate during the implementation of the project. Although some companies see this as a big concern, yet this is not considered as a big hurdle in accepting and adopting AEOLIX.

The results and findings regarding operational impact assessments of 12 different living labs highlights the importance of digital solutions like AEOLIX. Though the AEOLIX system is in its infancy stage of use, it has been proven useful and beneficial for various stakeholders within logistics and supply chain. Therefore, a continuation of the solution is a step forward toward addressing challenges face by the logistics and supply chain.

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Annex 1 – KPIs and Questionnaire

These interview questions are designed to collect data in order to perform the analysis related to D6.2, D6.3 and D8.5. You will be asked to respond as precisely as possible (through numbers, percentages, averages...) to questions related to the KPIs you have previously selected for D6.2. In case you still do not have the necessary data to provide an answer, please write “not available yet” explaining when you will be able to collect those data. If, on the contrary, you believe that you will not be able to provide an answer for a specific question, or if you have any doubt, please refer to giulia.renzi@icoor.it, asif.akram@chalmers.se and stig@chalmers.se.

KPI 1: Average fuel consumption

- 1.1. How do you measure fuel consumption (i.e. measurement units)?
- 1.2. How much was the average fuel consumption before (actual data) and after AEOLIX?

- 1.3. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX have an impact on the average fuel consumption ? Please, provide examples.					
To what extent does this change in the average fuel consumption impact the environment ? Please, provide examples.					
To what extent does the change in the average fuel consumption impact the economic/financial aspect ? Please, provide examples.					

KPI 2: Average number of trips with consolidated cargo

- 2.1. How much was the average number of trips with consolidated cargo before and after AEOLIX?

Please provide the data before and after AEOLIX:

1.4. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the change in the average number of trips with consolidated cargo have an impact on the environment ? Please, provide examples.					
To what extent does the change in the average number of trips with consolidated cargo impact the economic and financial aspect ? Please, provide examples.					
To what extent does the change in the average number of trips with consolidated cargo have an impact on the driver ? Please, provide examples.					
To what extent does the change in the average number of trips with consolidated cargo impact on the customer satisfaction ? Please, provide examples.					
To what extent does the change in the average number of trips with consolidated cargo impact on planning and overall performance ? Please, provide examples.					
To what extent does the change in the average number of trips with consolidated cargo improve the level of service/function ? Please, provide examples.					
To what extent does the change in the average number of trips with consolidated cargo increase the responsiveness of the service/function ? Please, provide examples.					

To what extent does the change in the average number of trips with consolidated cargo increase the efficiency (in terms of time) of operations? Please, provide examples.					
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KPI 3: % of Empty runs

3.1. How much was the % of empty runs before and after AEOLIX?

Please provide the data before and after AEOLIX:

1.5. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX impact the % of empty runs ? Please, provide examples.					
To what extent does the change in the % of empty runs impact on the environment ? Please, provide examples.					
To what extent does the change in the % of empty runs impact on the economic and financial aspect ? Please, provide examples.					

KPI 4: Average waiting time

4.1. How much was the average waiting time before and after AEOLIX?

Please provide a numerical answer indicating the increase or decrease:

4.2. Did this change in average waiting time bring a financial benefit?

4.3. Please, fill in the following table (do not forget to provide examples!):

Please provide a numerical answer:

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent the use of AEOLIX change the average waiting time ? Please, provide examples.					
To what extent does the average waiting time impact the driver ? Please, provide examples.					
To what extent does the change in average waiting time increase the efficiency of the operations ? Please, provide examples.					
To what extent does the change in average waiting time impact on planning and overall performances ? Please provide examples.					
To what extent does the change in average waiting time impact on the economic/financial aspect ? Please, provide examples.					

KPI 5: Average loading/unloading time

5.1. How much was the average loading/unloading time before and after AEOLIX?

Please provide the data before and after AEOLIX:

5.2. Did this average of loading/unloading time have an impact on the operational

Please provide a numerical answer:

costs?

5.3. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX have an impact on the average of loading/unloading time (per trip)?					
To what extent does the average of loading/unloading time have an impact on the efficiency of operations? Please provide examples.					
To what extent does the average of loading/unloading time have an impact in planning and overall performances? Please provide examples.					
To what extent does the average of loading/unloading time have an impact on the economic and financial aspect? Please, provide examples.					
To what extent does the average of loading/unloading time have an impact on the operational costs? Please, provide examples.					

KPI 6: Terminal Productivity

6.1. How much was the terminal productivity before and after AEOLIX?

Please provide the data before and after AEOLIX:

6.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX change the terminal productivity ? Please, provide examples.					
To what extent does the change in terminal productivity increase the efficiency of operations ? Please provide examples.					
To what extent does the change in terminal productivity help the planning and overall performances ? Please, provide examples.					

6.3. Did this change have an impact financially?

Please provide a numerical answer:

6.4. Did this change reduce operational costs

Please provide a numerical answer:

KPI 7: % of Load factor

7.1. How much was the percentage of load factor before and after AEOLIX?

Please provide the percentage of load factor before and after AEOLIX:

7.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX have an impact on the % of load factor ? Please, provide examples.					
To what extent does the change in the % of load factor help in improving the efficiency of operations ? Please, provide examples.					
To what extent does the % of load factor have an impact on the planning and overall performances ? Please, provide examples.					

7.3. Did this percentage of load factor bring a financial benefit

If so, please provide a numerical answer:

KPI 8: Average CO2 emissions

8.1. How much was the average CO2 emissions before and after AEOLIX?

Please provide the data before and after AEOLIX:

8.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX reduce the average of CO2 emissions ? Please, provide examples.					

To what extent does the change in the average of CO2 emissions have an impact on the environment? Please, provide examples.					
To what extent does the change in the average of CO2 emissions have an impact on the economic/financial aspect? Please, provide examples.					

KPI 9: Administration work

9.1. How was the administration work managed before and after AEOLIX?

Please provide the data before and after AEOLIX:

9.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX change the organization of the administration work? Please, provide examples.					
To what extent does the change of the administration work have an impact on the financial aspect? Please, provide examples.					
To what extent does the use of AEOLIX improve the workers' quality of life? Please, provide examples.					
To what extent does the change of the administration work have an impact on the service/function quality? Please, provide examples.					

KPI 10: Traffic avoidance/congestion reduction

10.1. How much was the time spent in traffic before and after AEOLIX?

Please provide the data before and after AEOLIX:

10.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX services/functions reduce travel time by avoiding the traffic congestion? Please, provide examples.					
To what extent does the traffic avoidance have an impact on the environment ? Please, provide examples.					
To what extent does the use of AEOLIX to avoid traffic have an impact on the driver quality of life ? Please, provide examples.					
To what extent does the use of AEOLIX services/functions to avoid traffic have an impact on the planning and overall performances ? Please, provide examples.					
To what extent does the use of AEOLIX services/functions to avoid traffic/to reduce congestion have an impact on the economic/financial aspect ? Please, provide examples.					

KPI 11: Level of service

11.1. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX services/functions change the level of customer satisfaction ? Please, provide examples.					
To what extent does the change of the level of service/function have an impact on the collaboration with partners ? Please, provide examples.					
To what extent does the change of the level of service/function improve the service quality ? Please, provide examples.					

11.2. How was the level of customer satisfaction before AEOLIX?

Please provide the data before and after AEOLIX:

11.3. How did the level of service change before and after AEOLIX

Please provide examples:

KPI 12: Modal shift (difference in % of cargo transported by road, rail or vessel over total cargo transported)

12.1. What is the % of cargo transported by the following over total cargo transported?

Mode of transport	Before	After
Road		
Rail		
Vessel		

12.2. To what extent, do you agree with the following statements:

	Extremely	To a great extent	Only a little	Not at all	I don't know
AEOLIX contributes to the modal shift for rail					
AEOLIX contributes to the modal shift for road					
AEOLIX contributes to the modal shift for vessel					
Modal shift has an impact on environment					
AEOLIX improves the drivers' quality of life					
The modal shift for rail has an impact on the environment					
The modal shift for road has an impact on the environment					
The modal shift for vessel has an impact on the environment					
The modal shift improves the quality of life of drivers.					
The modal shift improves the planning and overall performance.					

KPI 13: Custom Procedures

13.1. How were the custom procedures managed before AEOLIX? How did them change after the use of AEOLIX?

Please provide the data before and after AEOLIX:

13.2. Please fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX facilitate the custom procedures ? Please, provide examples.					

To what extent does the use of AEOLIX affect the workers' quality of life? Please, provide examples.					
To what extent does the change in custom procedures increase the responsiveness? Please, provide examples.					
To what extent does the change in custom procedures affect the planning and overall performances? Please provide examples.					
To what extent does the change in custom procedures impact on the economic/financial aspect? Please provide examples.					

KPI 14: Visibility / data sharing

14.1. To what extent does the use of AEOLIX increase the data sharing?

Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
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14.2. To what extent does the use of AEOLIX increase the visibility?

Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
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14.3. Did the change on visibility have an impact on the financial aspect?

If so, please provide a numerical answer indicating the increase or decrease (with a – sign):

14.4. Did the change on data sharing have an impact on the financial aspect?

If so, please provide a numerical answer indicating the increase or decrease (with a – sign):

14.5. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX have an impact on the visibility ? Please, provide examples.					
To what extent does the use of AEOLIX have an impact on the data sharing ? Please, provide examples.					
To what extent does the change of the visibility have an impact on the service quality ? Please, provide examples.					
To what extent does the change of the visibility have an impact on the efficiency of operations ? Please, provide examples.					
To what extent does the change of the data sharing have an impact on the overall performances ? Please, provide examples.					

KPI 15: Interoperability

15.1. How was the interoperability before and after AEOLIX?

Please provide the data before and after AEOLIX:

15.2. Please, fill in the table below (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know

To what extent does the use of AEOLIX improve the interoperability ? Please, provide examples.					
To what extent does the use of change in the interoperability have an effect on the efficiency of operations ? Please, provide examples.					
To what extent does the change in the interoperability have an impact on planning and overall performances ? Please, provide examples.					
To what extent does the change in the interoperability have an impact on financial/economic aspect ? Please, provide examples.					

KPI 17: Dynamic reconfiguration of shipments

17.1. How were the shipments organized before AEOLIX? How did they change with the use of AEOLIX?

Please, provide the data before and after AEOLIX:

17.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX services/functions change the dynamic reconfiguration of shipments ? Please provide examples.					

To what extent does the change in dynamic reconfiguration of shipments improve the service/function quality ? Please, provide examples.					
To what extent does the change in dynamic reconfiguration of shipments increase the efficiency of operations ? Please, provide examples.					
To what extent does the change in dynamic reconfiguration have an effect on planning and overall performances ? Please, provide examples.					

17.3. Did this change have an impact on the financial aspect?

If so, please provide a numerical answer indicating the increase or decrease (with a – sign):

17.4. Which problems were there before the use of AEOLIX that are now solved?

Please provide examples:

KPI 18: Terminal handling efficiency

18.1. How much was the terminal handling efficiency before (actual data) and after

Please provide the data before and after AEOLIX:

AEOLIX?

18.2. Fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX improve the efficiency of handling the terminal ? Please, provide examples.					
To what extent does the change in terminal handling efficiency impact the efficiency of operations ? Please, provide examples.					
To what extent does the change in terminal handling efficiency impact the planning and overall performances ? Please provide examples.					

18.3. Did the change in the terminal handling efficiency have a financial effect?

If so, please provide a numerical answer indicating the increase or decrease (with a – sign):

KPI 19: Reliability / Risks (Reliability of equipment)

19.1. How was the reliability of the equipment before (actual data) and after

Please provide the data before and after AEOLIX:

AEOLIX?

19.2. How did risks changed before (actual data) and after AEOLIX?

Please provide the data before and after AEOLIX:

19.3. Please, fill in the table below (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know

To what extent does the use of AEOLIX improve the reliability of the equipment ? Please provide examples.					
To what extent does the use of AEOLIX decrease risks ? Please provide examples.					
To what extent does the change in the risks have an impact on the economic/financial aspect ?					

KPI 20: Standardization

20.1. How did the standardization change before (actual data) and after AEOLIX?

Please provide the data before and after AEOLIX:

20.2. Please, fill in the following table (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
To what extent does the use of AEOLIX improve the standardization ? Please, provide examples.					
To what extent does the change in the standardization have created financial benefits ? Please, provide examples.					
To what extent does the change in the standardization improve the service/function quality ? Please, provide examples.					
To what extent does the change in the standardization increase the responsiveness ? Please, provide examples.					

To what extent does the change in the standardization increase the efficiency of operations? Please, provide examples.					
To what extent does the change in the standardization increase the planning and overall performances? Please, provide examples.					

20.3. Did the standardization have created financial benefits?

Please provide a numerical answer:

Financial benefits

16.1. The financial benefits from the visibility and monitoring element of AEOLIX solution can be measured between 1% and 10% (Grant Agreement p.18-19). Please provide the costs for each of the following cost types:

Cost Type with percent opportunity	Activities related to each Cost type	Before AEOLIX (please provide numerical answer)	After AEOLIX (please provide numerical answer)	Percentage Increase or decrease
Trade management labour (trade Monitoring) 5%+				
Logistics management (trade management) 5.5-6%				
Safety stock (reduction in stock) 7-9%				
Distribution centre operations (Reduction in facilities and labour) 3-5%				
Loss, damage and delay (Reduced delay and claim costs) 1-3%				
Insurance (reduction in premiums) more than 1%				

16.2. What are the major reasons for increase or decrease for each cost type?

Cost Type with percent opportunity	Reasons for increase or decrease for each cost type. If there is deviation from 'percent opportunity', please specify the reasons
Trade management labour (trade Monitoring) 5%+	
Logistics management (trade management) 5.5-6%	
Safety stock (reduction in stock) 7-9%	
Distribution centre operations (Reduction in facilities and labour) 3-5%	
Loss, damage and delay (Reduced delay and claim costs) 1-3%	
Insurance (reduction in premiums) more than 1%	

16.3.To what extent does the use of AEOLIX improve the financial benefits?

Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
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16.4.To what extent does the financial benefits of the AEOLIX services/functions have an impact in your future management decision?

Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
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Acceptance and trust

(degree of approval of a technology by the user)

21.1. Please, fill in the table below (do not forget to provide examples!):

	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
--	-----------	-------------------	------------------------	-----------------------	--------------

To what extent does the use of AEOLIX have an impact on the degree of approval of a technology by the user? Please, provide examples.					
To what extent does the change in the acceptance and trust have an impact on the relationship with the user? Please, provide examples.					
To what extent does the change in the acceptance and trust improve the service/function quality? Please, provide examples.					
To what extent does the change in the acceptance and trust increase the responsiveness? Please, provide examples.					
To what extent does the change in the acceptance and trust improve the efficiency of operations? Please, provide examples.					
To what extent does the change in the acceptance and trust and improve the planning and overall performance? Please, provide examples.					

21.2. To what extent the following AEOLIX services/functions are considered useful?

AEOLIX Services/functions	To a greater extent	To some extent	Yes, but only a little	Doesn't affect at all	I don't know
Dashboard					
Connectivity Engine					
Toolkit					
Other (Name)					

21.3. Before AEOLIX, to what extent following services/functions were perceived usable?

AEOLIX Services/functions	To a greater extent	To some extent	Yes, but only a little	Doesn't affect at all	I don't know
Dashboard					

Connectivity Engine					
Toolkit					
Other (Name)					

21.4. After AEOLIX, to what extent the following services/functions (actually) proved to be useful?

AEOLIX Services/functions	To a greater extent	To some extent	Yes, but only a little	Doesn't affect at all	I don't know
Dashboard					
Connectivity Engine					
Toolkit					
Other (Name)					

21.5. To what extent, users are willing to continue using the following services/functions?

AEOLIX Services/functions	To a greater extent	To some extent	Yes, but only a little	Doesn't affect at all	I don't know
Dashboard					
Connectivity Engine					
Toolkit					
Other (Name)					

21.6. To what extent, users trust on the following AEOLIX services/functions (in terms of their functionality, performance, support etc.)?

AEOLIX Services/functions	To a greater extent	To some extent	Yes, but only a little	Doesn't affect at all	I don't know
Dashboard					
Connectivity Engine					
Toolkit					
Other (Name)					

Costs and questions

→ **AS-IS costs:** the value of the pre-existing equipment needed to run the existing logistic services and that allowed to save costs for the deployment of the AEOLIX services/functions.

Questions: Did you have pre-existing equipment? (Telephone, telephone subscription, computers, telecommunication infrastructures, location, furniture...). If yes, please describe.

→ **Investment costs:** the investments needed for the deployment of the services functions.

Questions: Which investments were needed in order to deploy the AEOLIX services/functions (e.g. project management costs, personnel costs, equipment costs, location costs, installation costs, programming and testing costs, telecommunication infrastructures costs...)?

→ **Operational costs:** costs needed for operating and maintaining the AEOLIX services functions.

Questions: Which investments are needed in order to maintain the AEOLIX services/functions (e.g. hardware maintenance, software maintenance, telecommunications)?

Questionnaire for business and user groups

→ You and your organization are participating in AEOLIX as:

Business providing service(s)

Business consuming service(s)

Other (please clarify):

→ To what extent, following services/functions. have been implemented in your Living Lab?

Service/ function.	Extremely	To a great extent	Yes, but only a little	Haven't been implemented	I don't know
Data Sharing					

Data exchange					
Marketplace of logistic services					
Data and documents management					
Estimated time of arrival (ETA)					
Info on Visibility					
Routing guidance					
Customer brokerage services					
Port services					
E-CMR note					
Control Tower Solutions					
CO2 emission monitoring					

→ Would you characterise AEOLIX as a platform with solutions which creates benefits for the users?

Extremely

To a great extent

Yes, but only a little

Doesn't affect at all

I don't know

→ Please, for each service/function fill in the table below with all the relevant costs in order to provide the service to the market. For each cost category listed, please estimate its value. The values have to be calculated on an annual basis. In case of an investment, please refer to the expected period until the investment depreciates. **Please fill in only the tables that are relevant to your Living Lab activities /services.**

	Data Sharing		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify)			
Deployment			
Yearly Management cost			-----

	Data Exchange
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	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			-----

	Marketplace of Logistics Services		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			-----

	Data and documents management		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			-----

	Estimated time of arrival		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify)			
Deployment			
Yearly Management cost			-----

	Visibility		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify)			
Deployment			
Yearly Management cost			-----

	Routing		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify)			
Deployment			
Yearly Management cost			-----

	Customs' brokerage services
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	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			_____

	Port services		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			_____

	e-CMR note		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			_____

	Control Tower Solutions
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	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			-----

	CO2 emission monitoring		
	Cost for providing the service through AEOLIX (listing of the costs):	Please estimate in Euros the value of the costs:	In case of a long-term investment, how many years until depreciation?
Research			
Technical investment			
Other investment (please specify) _____			
Deployment			
Yearly Management cost			-----

→ Would you characterise AEOLIX as a platform with solutions which creates benefits for the users?

Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
-----------	-------------------	------------------------	-----------------------	--------------

→ For each service, please fill in the list below with all the relevant benefits. For each benefit category listed, please estimate its value, the values have to be calculated on an annual basis. In case of an investment, please refer to the expected period until the investment depreciates. **Please fill in only the tables that are relevant to your Living Lab activities / services.**

	Data sharing
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	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Data exchange	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Marketplace of logistics services	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Data and documents management	
--	-------------------------------	--

	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Estimated time of arrival	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Visibility	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Routing	
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	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Customs' brokerage services	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Port services	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	e-CMR note
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	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	Control tower solutions	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

	CO2 emission monitoring	
	Benefits from the service through the use of AEOLIX (listing of benefits):	Please valuate the benefits in Euros:
Financial		
Environmental		
Societal		
Operational		
Planning and performance		

→ Would you use AEOLIX in the future as a commercial product?

a. Yes, as a business providing service(s)



- b. Yes, as a business consuming service(s)
- c. Not at all
- d. I don't know

Annex 2 – Company Managers Questionnaire

The EU-funded project AEOLIX is hereby launching a questionnaire with the aim of evaluating Living Labs Operational Impact Assessment. Based on the description of work from the AEOLIX project, the evaluation will focus on the impacts related to socio-economic (job creation, SME empowerment, quality of life), business (reduced operation cost) and environmental aspects (CO₂ emission, noise pollution).

This questionnaire is intended for (business) managers dealing with operational level activities who have used (or intended to use) the system. The questionnaire must be answered by each manager (separately) of the following AEOLIX users and companies: Forwarders, terminal operators, Hauliers, customs operators, shippers and their customers.

Your responses will be analyzed but will remain confidential.

Basic Information:

1. What is the number of employees at your company?
 - a. No of employees -----
2. Which of the following roles does your company/organization have in its supply chain?
 - a. Forwarder / logistic service provider / logistic operator
 - b. Hub/Terminal Operator
 - c. Hauliers / Carrier / cargo operator
 - d. Shipper / manufacturer
 - e. Custom operator / rail operator / infrastructure operator / fleet and transport operator / vessel operator
 - f. Shipper customer / consignee
 - g. Retail and warehouse
 - h. Government (or legislative) authority (i.e. inland water, custom, road, rail)
 - i. Vessel owner
 - j. Other (please specify):
3. Do you own any mode of transport or do you use external partner and how many (e.g. 10 trucks)?

<i>Vehicles</i>	<i>Number</i>
Your Company own	
Rail	
Trucks	
Vessels	
External Partners Own	
Rail	
Trucks	
Vessels	

4. What is the average employment duration of employees in your company / organization?

- a. Less than 2 years
- b. 2-3 years
- c. 4-5 years
- d. 5-6 years
- e. More than 6 years

5. What (distribution) areas does your company/organization serve (tick all that apply):

	<i>Domestic</i>	<i>International</i>
<i>Rural</i>		
<i>Urban</i>		

6. What type of group(s) of goods/products do you usually deal with? (tick all that apply):

<i>Group</i>	<i>Groups of Products/goods</i>	<i>Tick below</i>
1	Products of agriculture, hunting, and forestry; fish and other fishing products	
2	Coal and lignite; crude petroleum and natural gas	
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	
4	Food products, beverages and tobacco	
5	Textile and textile products; leather and leather products	
6	Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media	
7	Coke and refined petroleum products	
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel	
9	Other non-metallic mineral products	
10	Basic metals; fabricated metal products, except machinery and equipment	
11	Machinery and equipment; n.e.c.; office machinery and computers; electrical machinery and apparatus; n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	
12	Transport equipment	
13	Furniture; other manufacturing goods n.e.c.	
14	Secondary raw material; municipal wastes and other wastes	
15	Mail, parcels	
16	Equipment and material utilized in the transport of goods	
17	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods n.e.c.	
18	Grouped goods: a mixture of types of goods which are transported together	
19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16	
20	Other goods	

7. What kind of cargo do you usually deal with? (tick all that apply)

<i>Type of Cargo</i>	<i>Tick below</i>
<u>Road/rail Freight Transport</u>	
Liquid bulk goods	
Solid bulk goods	
Large freight containers	
Other freight containers	
Palletized goods	
Pre-slung goods	
Mobile, self-propelled units	
Other mobile units	
Other cargo units not elsewhere specified	
<u>Sea Freight Transport</u>	
Liquid bulk	
Dry bulk	
Containers	
Ro-Ro units (wheeled vehicles that can be loaded and discharged without cranes)	
Other cargo	

8. To what extent, does the AEOLIX platform contribute to the reduction of “noise” at your workplace?

- Extremely
- To a great extent
- Yes, but only a little
- Doesn’t affect at all
- I don’t know

9. Please provide examples of how AEOLIX contribute to reduction of noise at your workplace (processes, activities or operations at your workplace. for which AEOLIX helped to reduce noise)?

<i>Name of process/activity/operation</i>	<i>Description how AEOLIX has helped to reduce noise</i>

10. Which of the following AEOLIX functions have you used?

- Dashboard
- Toolkit
- Connectivity Engine
- Management and Authentication functions
- Others (please specify):

11. In your opinion, which of the AEOLIX functions/services have helped to reduce high level of noise at your workplace?

<i>Name of Service</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>Dashboard</i>					
<i>Toolkit</i>					
<i>Connectivity Engine</i>					
<i>Management and Authentication functions</i>					
<i>Other (name):</i>					

Business Impacts:

12. What was the status (in terms of time spent) of various logistic activities /operations /processes (for example, pickup of shipment) BEFORE and AFTER AEOLIX?

<i>Name of activity/process / operation</i>	<i>BEFORE AEOLIX (Time spent, please provide figure)</i>	<i>AFTER AEOLIX (Time spent, please provide figure)</i>

13. To what extent has AEOLIX helped / will help to reduce the operational cost (in terms of time spent) for various logistics activities/operations/processes (for example pickup of shipment)? (as mentioned in Q. 11)

<i>Name of logistic activity/operation</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>

14. What is the status (in terms of money spent) of various logistic activities /operations /processes (for example, pickup of shipment) BEFORE and AFTER AEOLIX (provide estimated figure, if actual figure is not available)?

<i>Name of activity/process / operation</i>	<i>BEFORE AEOLIX (money spent, please provide figure)</i>	<i>AFTER AEOLIX (money spent, please provide figure)</i>

15. To what extent has AEOLIX helped / will help to reduce the operational cost (in terms of money spent) of various logistics activities/operations/processes?

<i>Name of activity/operation</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>

16. In your opinion, which of the AEOLIX functions/services have helped to reduce the operational cost (in terms of time spent) of various logistics activities?

<i>Name of AEOLIX function/Service</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>Dashboard</i>					
<i>Toolkit</i>					
<i>Connectivity Engine</i>					
<i>Management and Authentication functions</i>					
<i>Other (name):</i>					

17. In your opinion, which of the AEOLIX functions/services have helped to reduce the operational cost (in terms of money spent) of various logistics activities?

<i>Name of AEOLIX function/Service</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>Dashboard</i>					
<i>Toolkit</i>					
<i>Connectivity Engine</i>					

Management and Authentication functions					
Other (name):					

18. What is status of the followings COST TYPES BEFORE and AFTER use of AEOLIX (please provide figures for each type of cost):

<i>Cost Types with Percent Opportunity (as per AEOLIX Initial project description)</i>	<i>Sub-Cost of Individual activities or processes (if possible)</i>	<i>BEFORE AEOLIX (Time spent, please provide figure)</i>	<i>AFTER AEOLIX (Time spent, please provide figure)</i>
Trade Management Labor (Trade Monitoring) 5+%			
Logistics Management (Trade Management) 5.5-6%			
Safety Stock (Reduction in Stock) 7-9%			
Distribution Center Operations (Reduction in Facilities and Labor) 3-5%			
Loss, Damage and Delay (Reduced Delay and Claims Costs) 1-3%			
Insurance (Reduction in Premiums) <1%			

19. What are the main reasons for increase or decrease for each cost types (please provide at least 3 reasons):

<i>Cost Types with Percent Opportunity (as per AEOLIX Initial project description)</i>	<i>Sub-Cost of Individual activities or processes (if possible)</i>
Trade Management Labor (Trade Monitoring) 5+%	



Logistics Management (Trade Management) 5.5-6%	
Safety Stock (Reduction in Stock) 7-9%	
Distribution Center Operations (Reduction in Facilities and Labor) 3-5%	
Loss, Damage and Delay (Reduced Delay and Claims Costs) 1-3%	
Insurance (Reduction in Premiums) <1%	

Socio-Economic Impacts:

20. How many of the following jobs have been created to meet need for new skills that are required, or because AEOLIX led (or will lead) to expansion of business?

<i>Operational Level jobs</i>	<i>1-2 jobs per year</i>	<i>3-4 jobs per year</i>	<i>More than 5 jobs per year</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>Driver</i>					
<i>Operator</i>					

21. To what extent has the use of AEOLIX platform led (or will potentially lead) your company towards an increased market share (or more business)?

- Extremely (more than 10%)
- To a great extent (6% – 10%)
- Yes, but only a little (less than 5%)
- Doesn't affect at all
- I don't know

22. In your opinion, how likely are large organizations to collaborate with your company because of your use of the AEOLIX platform?

- Extremely
- To a great extent
- Yes, but only a little
- Doesn't affect at all

e. I don't know

23. In your opinion when is most useful to have the information for a given journey for one of your trucks? (several responses are possible for every suggestion)

	<i>At departure of the round</i>	<i>Mid-journey</i>	<i>At the end of the journey (less than 5 km left)</i>	<i>At the last km</i>	<i>At the arrival</i>	<i>I do not know</i>
<i>Knowledge of the place to deliver goods</i>						
<i>Knowledge of the Estimated Time Arrival (ETA) to the destination</i>						
<i>Knowledge of the availability of access to the destination facility at the ETA (port, terminal etc.)</i>						
<i>Probable waiting time at the arrival at the ETA</i>						
<i>Traffic status during the planned route</i>						
<i>Knowledge about the routes and the sequence of planned stops</i>						
<i>Sharing your own geographical position with the receiving organization</i>						

24. To what extent, do you agree with the following statements:

<i>After using AEOLIX...</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>More focus on my work</i>					
<i>Daily work is less stressful</i>					
<i>Peoples' attitude changes positively towards me</i>					
<i>I have been rewarded (fewer working hours, more relaxing</i>					

<i>time at work etc.)</i>					
<i>Others (please specify):</i>					

NOTE: Usability of AEOLIX platform is an important factor in deciding the acceptance and trust of the platform. This factor is measured in terms of the followings: easy to learn, efficiency of use, easy to remember, few errors, and subjective pleasuring

25. To what extent, do you agree with the following statements:

<i>Easy of Learning</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>BEFORE AEOLIX, I thought that learning on how to use AEOLIX will be quite easy</i>					
<i>AFTER AEOLIX, I found that learning on 'how to use AEOLIX' was easy</i>					

26. For how many hours (in a month, on average) have you used AEOLIX system (if possible please provide answers for each of the function of AEOLIX, separately)?

<i>Use of System</i>	<i>Less than 40 hours</i>	<i>41-80 hours</i>	<i>81-120 hours</i>	<i>121-160 hours</i>	<i>More than 160 hours</i>	<i>I didn't use it at all</i>
<i>AEOLIX Platform (In general)</i>						
<i>Dashboard</i>						
<i>Connectivity Engine</i>						
<i>Toolkit</i>						
<i>Authentication</i>						
<i>Other (Name)</i>						

27. Please explain the perceived and actual effects of AEOLIX (or AEOLIX functions, individually) in helping you to perform your daily tasks (if possible, please provide the description for each of the AEOLIX function):

<i>AEOLIX Platform</i>	<i>PERCEIVED effects of AEOLIX on your daily tasks (please provide specific examples)</i>	<i>ACTUAL effects of AEOLIX platform on your daily tasks (please provide specific examples)</i>
<i>AEOLIX Platform (In general)</i>		
<i>Dashboard</i>		
<i>Connectivity Engine</i>		
<i>Toolkit</i>		
<i>Authentication</i>		
<i>Other (Name)</i>		

28. Did you experience any errors while using AEOLIX System? If yes, to what extent?

<i>Easy of Learning</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Haven't</i>	<i>I don't know</i>
<i>Minor errors (The type of errors which I was able to correct by myself & they didn't significantly slowdown my work)</i>					
<i>Major errors (The type of errors for which I didn't know the solution. They results in delaying my work)</i>					

29. How often and how many major errors, did you experience while using AEOLIX system?

	<i>Frequency</i>
--	------------------

Number of Error:		High	Low
	High		
	Low		

30. After using AEOLIX platform (for one month, at least), to what extent do you agree with the following statements:

After using AEOLIX...	Extremely	To a great extent	Yes, but only a little	Doesn't affect at all	I don't know
It was very easy to learn how to use AEOLIX					
Using AEOLIX was a very frustrating experience					
I feel AEOLIX allow me to achieve high productivity					
I worry many things I did with AEOLIX are wrong					
AEOLIX could do all the things I needed/expected from it					
AEOLIX is very pleasant to work with					

31. How would you rate AEOLIX platform and services, in terms of the followings:?

Aspect	Totally disagree	Mostly disagree	Slightly disagree	Neutral	Slightly agree	Mostly agree	Totally agree
Overall, AEOLIX performed as expected							

<i>AEOLIX service subscription cost is reasonable</i>							
<i>Sharing information via AEOLIX is a big concern in my company</i>							
<i>Sharing information via AEOLIX is a big hurdle in adopting AEOLIX</i>							
<i>Time spent on learning AEOLIX proved to be useful</i>							

32. Would you be interested to own one or several of the proposed services below, via a subscription to AEOLIX platform?

- Yes
- No
- If Yes, could you please indicate which ones are the most important for you (boxes are left blank to fill in other services)?

<i>Service Name</i>	<i>Tick below (all that apply)</i>
Appointment service	
Estimated time of arrival (ETA)	
Real-time location of vehicle(s)	
Knowledge of the availability of the receiving organization (port, warehouse etc....)	

Free question

The questionnaire is now over. Thank you for your participation! The box below is dedicated to your free expression: Please provide your comments and suggestions about the AEOLIX platform in the box below.



Annex 3 – Drivers Questionnaire

The EU-funded project AEOLIX is hereby launching a questionnaire with the aim of evaluating Living Labs Operational Impact Assessment. Based on the description of work from the AEOLIX project, the evaluation will focus on the impacts related to socio-economic (job creation, SME empowerment, quality of life), business (reduced operation cost) and environmental aspects (CO2 emission, noise pollution).

Your feedback is very important to us. Your responses will be analyzed but remain confidential.

Basic Information:

1. **What is your gender?**
 - a. Male
 - b. Female
 - c. Prefer not to say
2. **How old are you?**
 - a. 18-24 years
 - b. 25-39 years
 - c. 40-54 years
 - d. 55 years or more
3. **How long have you worked with delivery of goods?**
 - a. Less than 3 years
 - b. 4 – 6 years
 - c. 7 – 10 years
 - d. 11 – 15 years
 - e. More than 15 years

Your Activity(ies):

4. **What type of delivery vehicle do you usually use? (tick all that apply)**
 - a. Truck van (>2.5t >= 3.5t)
 - b. Truck (>3.5t)
5. **What type of goods/products do you usually deliver? (tick all that apply)**

Group	Groups of Products/goods	Tick below
1	Products of agriculture, hunting, and forestry; fish and other fishing products	
2	Coal and lignite; crude petroleum and natural gas	
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	
4	Food products, beverages and tobacco	
5	Textile and textile products; leather and leather products	

6	Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media	
7	Coke and refined petroleum products	
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel	
9	Other non-metallic mineral products	
10	Basic metals; fabricated metal products, except machinery and equipment	
11	Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	
12	Transport equipment	
13	Furniture; other manufacturing goods n.e.c.	
14	Secondary raw material; municipal wastes and other wastes	
15	Mail, parcels	
16	Equipment and material utilized in the transport of goods	
17	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods etc.	
18	Grouped goods: mixed types of goods which are transported together	
19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16	
20	Other goods	

6. What is the delivery distance of your typical assignment?

- Local service (within the city)
- National service (between cities)
- International service between EU countries
- International service between the EU and non-EU countries

7. What types of facilities do you mainly serve? (tick all that apply)

- ☐ Ports
- ☐ Downtown/City center
- ☐ Warehouse/Distribution centers
- ☐ Urban/residential
- ☐ Rural
- ☐ Other specify:

8. At what time do you usually drive?

- In the morning (06hr -12hr)
- In the afternoon (12hr – 18hr)
- In the evening (18hr – 22hr)
- In the night (22hr – 01hr)
- Late night / early morning (01hr – 06hr)

9. On average, how many km do your drive per day, for one assignment?

- Less than 10 km
- Between 10 to 30 km
- Between 30 to 100 km
- More than 100 km

10. On average, how many trips do you have per day?

- a. More than 5 per day
- b. 3 - 4 per day
- c. 2 per day
- d. 1 per day
- e. 2 - 3 per week
- f. 1 or less per week

11. What is the average waiting time to enter terminal/port?

- a. I don't wait.
- b. 1 - 10 minutes.
- c. 11 - 20 minutes.
- d. 21 - 30 minutes.
- e. If more than 30 minutes, specify: minutes
- f. Not applicable

12. What is the average waiting time to exit from terminal/port?

- a. I don't wait.
- b. 1 - 10 minutes.
- c. 11 - 20 minutes.
- d. 21 - 30 minutes.
- e. If more than 30 minutes, specify: minutes
- f. Not applicable

13. To what extent do you think that AEOLIX services could be useful for you in your daily activities?

- a. Extremely
- b. To great extent
- c. Yes, but only a little
- d. Doesn't affect at all
- e. I don't know

14. Have you used the AEOLIX application for your driving?

- a. Yes (Please go to Q15)
- b. No (Please go to Q16)

15. To what extent, do you agree with the following statements:

<i>After using AEOLIX...</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>Exposure to the level of noise is reduced (e.g. avoiding noisy roads /</i>					

<i>communication etc.)</i>					
<i>More focus on my driving</i>					
<i>Driving is less stressful</i>					
<i>Peoples' attitude changes positively towards me</i>					
<i>I have been rewarded (fewer working hours, more relaxing time between jobs etc.)</i>					

16. Would you be interested in using the AEOLIX application to facilitate your driving trips?

- Extremely
- To great extent
- Yes, but only a little
- Doesn't affect at all
- I don't know

17. Suppose that you are in a process of delivery or pickup:

For each suggestion below, could you please tell us the best moment on your route that you think it is necessary to: (Tick all that apply)

	<i>At departure of the round</i>	<i>Mid-journey</i>	<i>Towards the end of the journey (less than 5 km left)</i>	<i>During the last km</i>	<i>On arrival</i>	<i>I do not know</i>
<i>Get good knowledge of the place to deliver/pick up</i>						
<i>Get good knowledge of the Estimated Time Arrival (ETA) to the destination</i>						
<i>Get good knowledge of the availability of access to the destination facility at the ETA (port, terminal etc.)</i>						
<i>Get the probable waiting time at the arrival at the ETA</i>						

<i>Traffic status during the route</i>						
<i>Knowledge about the route and sequence of planned stops</i>						
<i>Sharing your own geographical position with the receiving organisation</i>						

18. Suppose that you are making a local delivery round. You are notified about an upcoming delay (several hours) at the receiving organisation, what do you decide to do?

- a. Continue to drive, and then wait at the destination
- b. Return to the warehouse and make other deliveries while you wait
- c. Stop and wait for new information
- d. Other (explain):

.....

19. Free question

The questionnaire is now over. Thank you for your participation!

Please provide your comments and suggestions about the AEOLIX platform in the box below:

Annex 4 – Hub/Port/Terminal Operators Questionnaire

The EU-funded project AEOLIX is hereby launching a questionnaire with the aim of evaluating Living Labs Operational Impact Assessment. Based on the description of work from the AEOLIX project, the evaluation will focus on the impacts related to socio-economic (job creation, SME empowerment, quality of life), business (reduced operation cost) and environmental aspects (CO₂ emission, noise pollution).

This questionnaire is intended for operators at one of the target users and companies (port/hub/terminal) that have used (or intended to use) the AEOLIX system. Your responses will be analyzed but remain confidential.

Basic Information:

- 1. What is your gender?**
 - a. Male
 - b. Female
 - c. Prefer not to say

- 2. How old are you?**
 - a. 18-24 years
 - b. 25-39 years
 - c. 40-54 years
 - d. 55 years or more

- 3. How much experience do you have as an operator (or handling goods)?**
 - a. Less than 3 years
 - b. 4 – 6 years
 - c. 7 – 10 years
 - d. 11 years or more

- 4. Which of the following activities are you involved in?**
 - a. Only unloading
 - b. Only loading
 - c. Both, loading and unloading

- 5. On average, how many vehicles enter into port/terminal every week?**

.....

- 6. Where do you work?**
 - a. Sea port
 - b. Dry port
 - c. Both, sea and dry port
 - d. Terminal
 - e. Warehouse

7. What type of goods/products do you usually deliver? (tick all that are applicable)

Group	Groups of Products/goods	Tick below
1	Products of agriculture, hunting, and forestry; fish and other fishing products	
2	Coal and lignite; crude petroleum and natural gas	
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	
4	Food products, beverages and tobacco	
5	Textile and textile products; leather and leather products	
6	Wood and products of wood and cork (except furniture); articles of straw and planting materials; pulp, paper and paper products; printed matter and recorded media	
7	Coke and refined petroleum products	
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel	
9	Other non-metallic mineral products	
10	Basic metals; fabricated metal products, except machinery and equipment	
11	Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	
12	Transport equipment	
13	Furniture; other manufacturing goods n.e.c.	
14	Secondary raw material; municipal wastes and other wastes	
15	Mail, parcels	
16	Equipment and material utilized in the transport of goods	
17	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods n.e.c.	
18	Grouped goods: a mixture of types of goods which are transported together	
19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16	
20	Other goods	

8. What kind of cargo do you usually deal with? (tick all that apply)

Type of Cargo	Tick below
<u>Road/rail Freight Transport</u>	
Liquid bulk goods	
Solid bulk goods	
Large freight containers	
Other freight containers	
Palletized goods	
Pre-slung goods	
Mobile, self-propelled units	
Other mobile units	
Other cargo units not specified elsewhere	
<u>Sea Freight Transport</u>	
Liquid bulk	
Dry bulk	
Containers	
Ro-Ro units (wheeled vehicles that can be loaded and discharged without cranes)	
Other cargo	

9. What areas does your company/organization serve (*tick all that apply*):

	<i>Domestic</i>	<i>International</i>
<i>Rural</i>		
<i>Urban</i>		

10. What types of vehicles do you deal with? (*tick all that apply*)

- a. Truck van (>2.5t >= 3.5t)
- b. Truck (>3.5t)
- c. Ships
- d. I don't deal with any vehicles

11. Have you used the AEOLIX application to perform your daily tasks?

- a. Yes (Please go to Q13)
- b. No (Please go to Q14)

12. To what extent do you agree with the following statements:

<i>After using AEOLIX you...</i>	<i>Extremely</i>	<i>To a great extent</i>	<i>Yes, but only a little</i>	<i>Doesn't affect at all</i>	<i>I don't know</i>
<i>Exposure to the level of noise is reduced at my workplace</i>					
<i>Can complete my daily tasks successfully</i>					
<i>I feel more respected at the workplace</i>					
<i>People's attitudes change positively towards me</i>					
<i>I am rewarded (fewer working hours, salary etc.)</i>					
<i>Have control over my work</i>					
<i>Have less stress at work</i>					

13. Would you be interested in using AEOLIX application to perform your daily tasks?

- a. Extremely

- b. To great extent
- c. Yes, but only a little
- d. Doesn't affect at all
- e. I don't know

14. Suppose that a loading or unloading is in progress:

For each suggestion below, could you please tell us at which moment, you think it is necessary to:

Tick the cells of the table below, several responses are possible for each suggestion:

	<i>At the departure of the vehicle</i>	<i>Mid-journey</i>	<i>At the end of the journey (less than 5 km)</i>	<i>At the last km</i>	<i>On arrival</i>	<i>I do not know</i>
<i>Obtain knowledge of the availability of the receiving spot (at port/terminal/hub)</i>						
<i>Obtain knowledge of vehicle Estimated Time of Arrival (ETA) to port/terminal</i>						
<i>Communicate knowledge about the delivery spot (at port/terminal) to driver</i>						
<i>Obtain average waiting time at the arrival according to the estimated arrival time (ETA)</i>						
<i>Obtain traffic status during the driving route</i>						
<i>Communicate to the receiving place concerning a consignment</i>						
<i>Obtain knowledge of the geographical position of the vehicle</i>						

15. Suppose that you are expecting a delivery. In case of a major delay (several hours), how do you advise the driver?

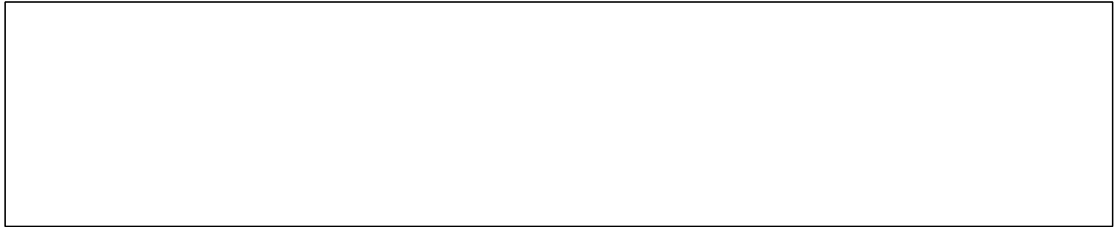
- a. ☐ Continue the journey and then wait at the arrival
- b. ☐ Come back to the warehouse and make another delivery
- c. ☐ Stop the vehicle and wait for new evolution information
- d. ☐ Other (please specify):

.....

16. Free question

The questionnaire is now over. Thank you for your participation!

Please provide your comments and suggestions about the AEOLIX platform in the box below:



Annex 5 – Link between Aspects at Operational Level and Questionnaires

Following picture shows the link between questionnaires and various aspects at operational level

